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PROGRESS REPORT ON RESEARCH AND RELATED SERVICES  
APPLICABLE TO  
GRAIN

Including Work in United States Department of Agriculture  
and Cooperative Studies with  
the State Experiment Stations

\* \* \*

Prepared for Use in Connection with the  
February 1956 Meeting of the  
Grain Research and Marketing Advisory Committee

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This Progress Report is a "tool" for: (1) Advisory committee use in formulation of recommendations in regard to present and future programs; (2) Administrative use in program development, coordination and evaluation. The material in this Report is not for publication. The Report includes research findings that have already been released. When mention is made of these findings, the publication containing the public release is also cited. Any reference to published findings should mention the publication in which the release was made, not this Progress Report. Included also are many tentative findings that have not been sufficiently tested for public release. When results are ready for release, the information will be made available through established channels.

For the reasons given, copies of the Report are available only to research administrators and workers directly concerned with the development and conduct of the program and to advisory committee members. Those receiving it are asked to observe strictly the limitations: "Administratively Confidential -- (Not to be Quoted or Copied)."

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UNITED STATES DEPARTMENT OF AGRICULTURE  
WASHINGTON, D. C.  
January 1956

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## FUNCTIONS OF ADVISORY COMMITTEES

The Grain Research and Marketing Advisory Committee is one of a number of committees authorized by Congress in 1946 to advise the Department of Agriculture with respect to specific research and service work.

The committees have been asked to consider all of the research and marketing service work of the Department in their respective fields. This is the recognition of the value the Department places upon the advice and counsel received and is in accord with suggestions of Congressional committee members who are directly concerned with the work.

The committees are performing an important function in advising with respect to the development of the Department's research and marketing service programs. However, it is recognized by members of Congress, committee members, and the Department that the implementing and administering of these programs are the responsibility of the Department.

The functions of the advisory committeemen include:

1. Acquainting themselves with the problems of consumers, producers, all segments of the industry and of other groups, and presenting them for committee consideration.
2. Reviewing and evaluating the current research and marketing service programs of the Department, including work under way at Federal laboratories and field stations.
3. Recommending adjustments in the Department's program, including priorities for new work and expansion of work under way.
4. Developing a better understanding of the nature and value of the agricultural research program, explaining it to interested persons, groups and organizations and encouraging the wider and more rapid application of the findings of research.

## COOPERATION

Much of the research on grain covered in this report is conducted in cooperation between agencies of the United States Department of Agriculture and the State Experiment Stations. The studies find their origin in problems of producers, processors, distributors and consumers, and representatives of these groups frequently participate in the cooperation. Cooperative programs are jointly planned and conducted in a manner to make full use of the personnel and resources of each participating group with the minimum of duplicative effort. The results of cooperative research are jointly prepared in the form of uniform recommendations.



USDA AGENCY ABBREVIATIONS

ARS - Agricultural Research Service

AE - Agricultural Engineering Research Branch  
APH - Animal and Poultry Husbandry Research Branch  
CRP - Crops Regulatory Program  
DH - Dairy Husbandry Research Branch  
ENT - Entomology Research Branch  
EU - Eastern Utilization Research Branch  
FC - Field Crops Research Branch  
HE - Home Economics Research Branch  
HN - Human Nutrition Research Branch  
LRP - Livestock Regulatory Program  
NU - Northern Utilization Research Branch  
OES - Office of Experiment Stations  
PE - Production Economics Research Branch  
SU - Southern Utilization Research Branch  
SWC - Soils and Water Conservation Research Branch  
WU - Western Utilization Research Branch

AMS - Agricultural Marketing Service

AEC - Agricultural Economics Division  
AES - Agricultural Estimates Division  
MR - Marketing Research Division  
MOC - Marketing Organization and Costs Branch  
TF - Transportation and Facilities Branch  
BS - Biological Sciences Branch  
MD - Marketing Development Branch  
FRS - Freight Rate Service Branch  
GR - Grain Division

LO - Liaison Office, Commissioner of Agriculture

ACPS - Agricultural Conservation Program Service

CSS - Commodity Stabilization Service

FAS - Foreign Agricultural Service

FCS - Farmer Cooperative Service

FES - Federal Extension Service

FS - Forest Service

REA - Rural Electrification Administration

SCS - Soil Conservation Service



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PROGRESS REPORT  
FOR  
GRAIN RESEARCH & MARKETING ADVISORY COMMITTEE  
MEETING  
February 13-15, 1956

I. PRODUCTION RESEARCH (Progress Report)

A. BREEDING AND PHYSIOLOGY

1. Rust Resistant Varieties of Spring Wheat FC-ARS

Varieties of durum and hard red spring wheat with resistance to 15B stem rust are now becoming available in volume. A very satisfactory increase of Selkirk was made in 1955 and in North Dakota alone it is estimated that about 4,000,000 bushels were produced. The durum increases likewise were successful.

About 15,000 acres of Sentry durum were grown. This variety is moderately susceptible to stem rust but has a tolerance factor, allowing considerable infection but with little damage unless infection comes quite early in the season. Four highly resistant durums were propagated by the North Dakota Agricultural Experiment Station as a winter crop in Arizona from which nearly 8,000 bushels of seed were obtained for sowing late in the spring of 1955 in North Dakota and Minnesota. There is now available about 120,000 bushels of seed for increase this winter and next summer, after which ample supplies of these varieties should be available for all of the farm acreage sown to durum wheat. These four varieties, now known as Id. 364, Id. 369, Id. 370, and Id. 372, will be given names in the near future.

Small increases of several other promising stem rust resistant spring wheats were made but none are far enough along to warrant listing. Willet, announced in last year's report as being ready for release, was discarded because of inferior quality.

2. New Varieties of Hard Red Winter Wheat FC-ARS

Texas has increased for possible release a new high quality, medium early maturing variety for which the name Crockett has been proposed. This variety carries the high leaf rust resistance of the Sinvaloch type and considerable stem rust resistance derived, in part, from Hope spring wheat. The variety is expected to replace Wichita, Early Blackhull, and Triumph to some extent in the Rolling Plains and West Texas area.

Oregon and Washington have released Columbia, an improved hard red winter variety for the dryer areas, after final commercial milling and baking tests were run on the 1955 crop. Columbia is higher yielding and has greater smut resistance than the standard varieties in the area. It was bred from the cross Rio-Rex x Nebred.

3. New Varieties of Soft Red Winter Wheat  
Wheat for the Eastern States

FC & ENT - ARS

As a result of nearly 30 years of breeding and research, two new varieties, Dual and Vermillion, were released from the Purdue University. Dual is a particularly timely release as it is resistant to hessian fly. Vermillion resembles Knox, released two years ago, but has had less loose smut infection than the Knox variety. Both are resistant to the more common races of leaf rust and have some resistance to stem rust.

4. New White Club Wheat

FC-ARS

A joint release of the Omar variety is being made this year by Oregon, Washington, and Idaho. It was developed specifically to replace Elmar in the higher rainfall areas of the Pacific Northwest. It is a derivative of Elgin - 19 x Elmar, has brown chaff, and good quality white grain. Omar has very high resistance to the known races of bunt.

5. International Rust Tests Reveal Broad  
Resistance in Domestic and Foreign Wheats

FC-ARS

In 1953, 713 different spring wheats were observed in the international rust nurseries. During the last two years 507 and 384 entries have been tested. The tests were grown in six continents, in 16 countries, and results were obtained from 37 locations in 1954. This illustrates the broad scope of the tests. Observations have been obtained on varietal reaction to stem rust, leaf rust, stripe rust, mildew, and several other diseases. A winter wheat rust nursery has been initiated, containing 98 entries grown at 6 places in 1954 and 182 varieties at 13 locations in the current season.

Several selections from the breeding program at the Minnesota station have shown consistent resistance at all locations. In the background of these selections are the parental varieties Kenya 58, Kenya Farmer, Frontana, Newthatch, Mida, Thatcher, McMurachy, and Exchange. Rather unusual gene combinations have been developed in these highly resistant derivatives since the parents have been susceptible at one or more locations.

Wheat varieties and selections in the International Rust Nurseries were tested in Peru for reaction to the virulent wheat stem rust race 189. Several sources of resistance to this race were determined, notably, selections from Frontana x K58-Newthatch crosses which likewise were resistant to stem rust races in all other South American countries. Kenya 58 appears to contain the critical factor governing resistance to this race. In addition to the regular set of wheats in the rust nursery being grown in Peru currently, 198 durum varieties have been added from the breeding program in North Dakota. Race 189 has not been reported in the United States but its ability to attack all of our commercial wheats make it one of the most feared races in existence.



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6. New Sources of Resistance to Rust and  
Other Diseases Coming From Species Hybrids  
and Irradiation Experiments

FC-ARS

The leaf rust resistance of Aegilops umbellulata has been transferred to common wheat by means of a rather complex procedure involving the use of the amphiploid Triticum dicoccoides x Ae. umbellulata, backcrossing, and x-ray treatments. One derivative that provides near immunity to all 22 races of leaf rust to which it has been tested shows no deleterious effects in plant growth characteristics. Male transmission rates suggest these are simply intercalations of a small segment of the Aegilops chromosome into wheat chromosomes. This method by which a small segment of a chromosome of a related species can be transferred to a wheat chromosome may have wide applications. It might be used, for example, in transferring desirable characteristics from rye to wheat.

In another study using similar techniques, the high degree of resistance to leaf and stem rust of Aegilops speltoides apparently has been transferred to common wheat. In this case undesirable characters have been transferred simultaneously with the resistance to rust. If additional attempts to separate the desirable from the undesirable genes are unsuccessful, irradiation will be tried.

From 20 years of experiments have come nearly 1,000 new selections of wheat from the Agropyron x Triticum crosses. Some of these are quite wheat-like whereas most of them are intermediate between grass and wheat in appearance. In greenhouse tests, many lines have shown an immune reaction to several races of stem rust combined with resistance to several other diseases. High resistance to streak mosaic virus has been shown in a two-year test. These 1,000 selections are being propagated so that adequate supplies of seed will be available for plant breeders to use in subsequent years. Support for this work has been withdrawn, hence, the Agropyron-Triticum exploratory research has been discontinued.

Irradiation with x-rays and thermal neutrons is being used to develop new resistance to rust, blight, and mildew. Several 15B rust resistant lines from irradiated Lee spring wheat are being increased for agronomic tests next year.

7. Wheat Quality Studied by Infra-Red Technique  
and by Leaf Feeding of Plants

FC-ARS

Evidence obtained by applying the infra-red technique to wheat gluten indicates that protein molecules in a stretched gluten film are not oriented. The reverse is commonly believed to be true of gluten structure after optimum development of the dough. This observation was confirmed by examination under an electron microscope. Additional investigation of this problem is contemplated.

Study of the effect on wheat quality of certain nitrogen and sulfur compounds sprayed on the leaves of the growing plant has been continued. Ethylene thiourea and N, N<sup>1</sup> diethylthiourea increased the protein content of the flour by amounts ranging from 2.5 to 4.5 percent and the sulfur content by about 20 percent. Spraying with ethylene thiourea reduced loaf volumes to only about 40 percent of what would be expected on the basis of the protein content. Most other compounds had little effect. Whether the additional sulfur is in the form of amino acid sulfur has not been determined. A new viscometer for characterizing protein and protein fractions in studies of this kind has been developed.

8. Effect of Diseases on Quality of Wheat FC-ARS

Studies conducted at the Hard Wheat Quality Laboratory on wheat infected with scab (Gibberella saubineti) verified the well known fact that quality is seriously affected by this disease. A hand picked sample of 100 percent scabby kernels produced a heavy soggy loaf, the volume of which was slightly larger than would be expected of a flour containing no protein whatever. Comparative studies on the proteolytic activity in flours from scab infected wheat and pre-ripe wheat suggests that the scab organism killed in the wheat prematurely and before the nitrogen had been synthesized into protein.

Paired samples of grain grown on healthy and streak mosaic virus of soil-borne mosaic virus infected plants were analyzed for quality. The diseased samples, in general, were characterized by somewhat longer mixing time, better crumb grains, and larger loaf volumes than the corresponding controls. While this result is contrary to what might have been surmised, it fits well with other findings that have shown how rate of maturity and weather conditions affect quality.

9. Bulk Method of Breeding Made More Effective by Modified Procedure FC-ARS

A modified bulk method of breeding promises to greatly speed up and increase the efficiency of breeding for improved quality. The method also appears to be promising for characteristics such as test weight, time of maturity, straw strength, and shattering, but not for yield. The method consists essentially of rapidly increasing the seed produced by each of a large number of F<sub>2</sub> plants in bulk either with or without selection. Bults from different F<sub>2</sub> plants can then be compared for quality characteristics, test weight, etc., as soon as a sufficient quantity of seed is available. Quality tests, for example, can usually be made in F<sub>4</sub> and verified in F<sub>5</sub>. Selection for additional characters can then be made from among the better quality lines. Just why this method has not proved effective for choosing the bulk from which high yielding selections may be expected is not clear.



10. Fungal Enzymes in the Flour and Doughs of  
Wheat Varieties

FC-ARS

It is estimated that between 60 and 75 percent of the bread in the United States is made using fungal enzymes. Protease and alpha-amylase supplements, in particular, are the outgrowth of basic research. Properly supplemented flour produces loaves that are symmetrical and soft, with grain and texture characteristics that are superior to those normally obtained by use of other enzyme supplements. More precise enzymatic control in varietal evaluation is now possible. The line project under which this work was conducted has been terminated and a summary paper prepared.

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11. New Varieties of Oats

FC-ARS

Minland is a new stem-rust, crown-rust, and smut-resistant oat variety developed in Minnesota from the cross Landhafer x (Mindó x Hajira-Joanette). It is highly resistant to all prevalent races of crown rust, to all except 7A of the known races of stem rust and is resistant also to both loose and covered smut. Minland is an early variety, about like Andrew for height, maturity and seed size, but superior for yield and strength of straw. It is the only variety now available with combined high resistance to all widely prevalent races of crown rust, stem rust, and smut. New race 7A of stem rust, which was present in trace amounts in 1954 and 1955, poses as a threat to Minland.

Ransom and Garry are the only oat varieties now available to farmers, possessing field resistance at moderate temperatures to all known races of oat stem rust. They possess the ABC genes inherited from Richland (A) and Hajira (BC). Ransom is an early maturing variety developed in Iowa and increased, named and released, in North Dakota. Garry is a later maturing variety developed, named, and released in Canada, and also being increased for distribution in New York. Ransom and Garry are both moderately resistant, under field conditions, to the now prevalent races of crown rust. Both varieties are susceptible to the Septoria disease of oats. Ransom is not a high yielding or high test weight variety. Its advantage is its high resistance to stem rust and early maturity. Garry is outstanding for yield and grain quality, but is somewhat limited in adaptation in the United States because of late maturity.

A promising new oat variety increased and named in 1955 is Bentland. It was developed in Indiana from the cross Benton 7-x Landhafer. Developed by backcrossing, it possesses the Landhafer resistance to all races of crown rust generally present in North America, and is like Benton for yield, grain quality, straw strength, height, maturity and resistance to stem rust, smut, Septoria, and other diseases. Like Benton, it also is susceptible to races 6, 7 and 7A of stem rust. It should replace the considerable acreage of Benton now being grown in Indiana and other states, as seed becomes available.

A second new oat variety distributed from Indiana in 1955 is Newton. It compares favorably with Clinton 59 and Clintland in performance and offers a seasonal adaptation and stem rust resistance which differ from and are complementary to these very popular varieties. Newton has been outstanding in Indiana for grain quality and strength of straw. It has been moderately resistant to crown rust and is resistant to races 2, 5, 7 and 7A of stem rust, but susceptible to races 6 and 8.

A new variety early yellow oat that appears to have promise in the Western Great Plains under dry land conditions is Palomino. Developed from a cross of Andrew x Clinton, it was named and released in North Dakota. Palomino has been superior to Gopher, Ajax and Marion, particularly in dry years. It is stiff strawed, has good test weight, and is resistant to smut, and races 2, 5, 8 and 10 of stem rust. The rusts ordinarily do not prevail west of the one hundredth meridian, where Palomino is recommended.

12. Resistance to Cat Stem Rust

FC-ARS

There are three known sources of basic resistance to the important cat stem rust disease. These are the Richland (A), "Canadian" or Hajira (BC), and White Russian or White Tartar (D) genes. Until very recently it was thought impossible to combine the Richland (A) and White Tartar (D) types of resistant, because of the apparent complete linkage, or allelic relationship, of the A and D genes. Workers at Minnesota now have developed selections of [Landhafer x (Mindoo x Hajira-Joanette)] x Andrew with the long desired combination of the ABCD genes - giving high resistance to all known races of stem rust plus the Landhafer high resistance to crown rust. Some of the lines possessing this unusual combination of high resistance to stem and crown rust are proving to be high yield and grain quality, stiff strawed and have other desirable agronomic qualities.

13. Winter Hardiness in Oats

FC-ARS

In the 13 states comprising the Southern Region oats are grown largely from fall seeding. In that Region at 76.5 percent increase in oat acreage has occurred during the past ten years. This increase has been almost exclusively in fall-sown oats. The major reasons for this increase were the release of varieties that were crown rust resistant and others that were more winter hardy. Farmers in New York, Pennsylvania, New Jersey, Delaware, Maryland and the Southern parts of Ohio, Indiana, Illinois, Missouri and Kansas also are showing increased interest in the new more winter hardy varieties of oats now becoming available for their area. It has been determined that Wintok withstands cold winters 40 percent more often than does the hardiest oat of 30 years ago. Outstanding winter hardy varieties such as Wintok, Forkeddeer, Fulwin, Pentagon, Lee, Hairy Culberson and New York Sel. (C.I. 5364) are being extensively utilized in crossing for recurrent selection, irradiation and conventional breeding programs to produce more hardy oats. In preliminary winter hardiness tests of irradiated and non-irradiated winter oat varieties it appears that some progenies from irradiated seed of New York Selection (C.I. 5364), Dubois, Arlington, and Atlantic, possess a significantly greater degree of hardiness than similar progenies from non-irradiated seed. X-ray and neutrons were used for irradiating the seed planted.

14. Varietal Differences in Protein Content of Oats FC-ARS

Highly significant differences in the protein content of the grain of 15 oat varieties included in the Uniform Fall Sown Nursery and of 70 varieties and strains from the World Oat Collection were found. These and other results indicate that oat varieties vary to a considerable extent in their protein content and that it should be possible to breed for high yield and high protein content. A number of Bond derivatives such as C.I. 5298, Mohawk, Clinton, Delair and Taggart have been high in protein content, while all 12 entries from Turkey were consistently low. The protein range was from 11.4 to 16.2 percent.



15. Breeding Stiff Strawed Oat Varieties

FC-ARS

With the increased need for growing high yielding oats on high fertility soils, and usually as a companion crop for legume or grass seedings, the development of stiffer strawed oat varieties has become of major importance. The World Collection of Oats was grown under irrigation in 1955 and carefully screened for stiff-strawed entries. Approximately 100 apparently diverse types were selected as being outstanding for stiff straw, among the approximately 5,000 entries in the entire collection. These 100 entries, which were mainly unnamed foreign introductions, will be observed and carefully tested for lodging resistance on both dry and wet soil in 1956. Then it is hoped that about 12 widely diverse types, each outstanding for lodging resistance, can be selected for an intensive recurrent selection breeding program for the development of new parental sources of outstanding lodging resistance in oats. The first, and probably most difficult, step has been achieved in finding so many apparently new sources of outstanding stiff straw.

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#### 16. Blight Resistant Lines of Corn Released FC-ARS

Four new blight resistant inbred lines were released to commercial seedsmen and growers on April 1, 1955. The newly released lines are CI.38B, CI.42A, CI.317B and CI.64. The first three lines are blight resistant recoveries of three of the four parents of U.S. 13, for many years the most widely grown hybrid in the United States. CI.38B is a blight resistant recovery of 38-11, CI.42A a blight resistant recovery of Hy, CI.317B a blight resistant recovery of L317 and CI.64 is a blight resistant recovery of K64. In tests conducted in 1952 and 1954, CI.38B was about equal in yield and standing ability to 38-11, CI.42A was considerably higher yielding than Hy but had a slightly lower record for standing ability, and CI.317B yielded appreciably more and had a better record for standing ability than L317. Comparisons of CI.64 and K64 conducted in 1952 indicate that CI.64 is higher yielding, has a better record for standing ability and is appreciably more resistant to leaf blight than K64.

#### 17. Two New Corn-Belt Hybrids Released FC-ARS

Two new hybrids developed in the North Central Regional Program were assigned AES designations and approved for release to growers. The new hybrids and their pedigrees are listed below:

AES512 (WF9 x M14) x (B9 x W22)	- Formerly Ind. 0421
AES807W (H26 x H27) x (H28 x H29)	- Formerly Ind. 9502

AES512 was tested in the cooperative AES tests in 1953 and 1954 and was the highest yielding entry in the test. It had a good record for a stalk breaking and ear dropping but was a little deficient for resistance to root lodging. AES807W also has been tested for two years and has made a good record for yield, lodging resistance and ear dropping.

18. Borer-Resistant Lines of Corn Being Developed

FC-ARS

In cooperation with entomologists of the Corn Borer Research Laboratory, a breeding and selection nursery was continued in 1954 for the purpose of selecting for corn borer resistance in early generation inbreds from open-pollinated and synthetic varieties and crosses of existing inbred lines. All lines which have been selected in this nursery in past years and which are being continued after four to five generations of self-pollination and selection for characters other than borer resistance were grown and retested for their borer reaction. Of 546 such lines 33 percent were rated highly resistant, and an additional 42 percent were rated intermediate in resistance. Information was also obtained in the same plots on reaction of the strains to corn rust and to the corn leaf blight caused by Helminthosporium turcicum. A few of the lines appeared to have a satisfactory level of resistance to both diseases as well as to the corn borer. Evaluation of other agronomic characteristics in hybrid combinations were begun.

19. Study of Potassium Uptake by Corn Plants

FC-ARS

Potassium uptake during the life cycle of corn was studied by growing plants in nutrient solutions and sampling every 2 or 3 days to determine the amount removed. When excess potassium was available in the nutrient solutions the plants removed larger quantities than were required for growth. During the grand period of growth all of the potassium in the solution was removed and accumulated in the plants. When the plants were maturing vegetatively smaller quantities of potassium were accumulated than in earlier stages. About 8 grams of potassium were accumulated per plant during the season which would mean a requirement of about 250 pounds of potash per acre with a stand of 14,000 plants per acre. There was no evidence that potassium moved from aerial portions of the plants back into the nutrient solution.

20. Development of High Oil Waxy Hybrids

FC-ARS

Yield trials of waxy single and double crosses were continued in 1954. The new lines of High Oil x B10 parentage continue to show promise. Seed was produced of a number of waxy mutants which are intermediate between waxy and normal in percent amylose. Studies are under way of the dosage effects of the intermediate and normal types with respects to percent amylose and pasting characteristics of the starch. Recurrent selection to develop a high oil percentage in waxy stocks is being continued. The waxy gene is being introduced into a series of new lines of promise by backcrossing.

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## 21. Hybrid Sorghum

FC-ARS

Research toward development of commercial sorghum hybrids of both the grain and forage types has been intensified. Extensive yield tests of hybrids conducted in 1955 generally have confirmed expectations of 20 to 40 percent yield increases over standard varieties of similar maturity. In some of the tests grown under severe drought conditions the hybrids lodged more than did standard varieties. Resistance to lodging must continue to be a major phase of the breeding program. Crosses of chinch bug susceptible lines with lines having resistance or tolerance showed little indication of chinch bug injury. Commercial production of seed of

some hybrids will be recommended in 1956. Enough seed should be available for planting several hundred thousand acres to hybrids in 1957. Preliminary tests indicate that hybrids may make possible the production of forage sorghum seed on short plants that can be harvested with a combine, thus reducing the cost and relieving the present shortage of good seed of forage sorghums.

22. Breeding Sorghums Resistant to Corn-Leaf  
Aphids

FC-ARS

Resistance to aphids was found in a plant selection of Piper sudan grass. This plant has been crossed with grain sorghum in an attempt to transfer its resistance into grain varieties.

Publications:

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23. New Varieties of Winter Barley

FC-ARS

A new variety of barley named Mo. B-475, selected from the cross Admire x Missouri Early Beardless, was distributed to foundation seed producers in Missouri in the fall of 1955. This variety has good resistance to loose smut, has good straw, and has been higher yielding and threshes cleaner than Mo. B-400, the predominant variety in Missouri.

Another new variety was distributed for increase in Ohio. This variety, named Dayton, was selected from a Composite Cross. It has moderate winter-hardiness, good straw, high yield, and early maturity.

24. Yield Increases Now Assured in Barley

FC-ARS

Further evidence obtained this year with isogenic lines of barley confirm the statement made last year, that for certain of the barley growing areas it should be possible to increase the yield of barley by 15 to 18 percent. This increase can be accomplished by transferring the yield factors linked with the 6-row character from a 6-rowed variety to a 2-rowed variety by the backcross method. This increase should be possible in the Rocky Mountain irrigated area and the Great Plains where adapted 2-row varieties equal or exceed the yields of the 6-rowed sort. Several such 2-rowed varieties have been found and the necessary breeding work has been started.

25. Quality Tests With 2-Rowed Barleys

FC-ARS

A preliminary survey of the malting quality of the agronomically satisfactory 2-rowed varieties selected from the World Collection of about 900 varieties was completed this year. From this number 30 varieties were selected for further tests. The Moravian variety, which is grown in Colorado, was found to be better in quality than Hannchen and Nanna, the varieties commonly grown for malting. Moravian, however, is low in yield and thus its area of production is not extensive. Among the varieties which are appreciably better than Hannchen in yield and straw strength, Betzes shows the most promise for quality. Extensive quality tests with Betzes and other promising varieties are underway and it is likely that one or two 2-rowed varieties will be released to farmers in the near future.

26. Relation of X-Ray Effects in Barley and  
Water Content of Seed

FC-ARS

Detailed studies conducted during the year showed the existence of a close relationship between the sensitivity of barley seeds to X-ray effects and the water content of the germs of these seeds. The results showed that the sensitivity of the seeds decreased as the water content of the germ increased from 4 to 8 percent and that additional amounts of water greater than 8 percent had no further influence on sensitivity. This information will be valuable in connection with the use of radiation for crop improvement work. The data obtained also suggest the need for reviewing the idea that radiation effects are accomplished through water as an intermediate agent.

Publications:

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B. INSECTS, DISEASES, PARASITES, ETC.

1. Large-scale Tests Establish Effectiveness of New Chemicals for Smut Control FC-ARS

Preliminary tests at the Washington Agricultural Experiment Station indicated that soil-borne common bunt may be controlled by treatment with hexachloro-benzene preparations. They are not effective against dwarf bunt. Tests on a commercial scale were made this year. Results were very satisfactory. In addition, an extensive nursery-scale trial was made involving 5 states of the Northwest. The treatment was effective at all locations. This development is an adjunct to resistant varieties as a means of combatting bunt.

2. Hessian Fly Resistance Related to Hemicellulose FC & ENT - ARS and Enzymes in the Wheat Plant

A study of varieties of wheat that differ in their resistance to hessian fly revealed significant differences in respiration activity which were not however related to resistance. Likewise, there was no relation between hydrogen-ion concentration and resistance. Chromatographic analysis indicated a marked increase in the amount of sucrose, glucose, and fructose in infested plants. It was also found that the hessian fly larvae secretes a substance which blocks the activity of plant phosphorylase. This enzyme is responsible for building the higher carbohydrates from the sugars produced during photosynthesis. Hemicellulose and degree of resistance were positively correlated. Larvae secrete hemicellulase as well as something that interferes with the action of plant phosphorylase.

3. Sorghum Head Smut FC-ARS

This soil-borne disease, for which there is no effective seed treatment, infected 100 percent of the plants in some varieties at Akron, Colorado and Lincoln, Nebraska in 1953 and 1954. Infected plants produce no grain. Studies have been made to develop methods of testing varieties for resistance to the disease. There are sources of resistance in both the grain sorghum and forage sorghums. In studying the disease it has been found that infection may take place after the seedling stage. The longevity of the spores in the soil in the absence of a susceptible host has not yet been determined.

4. Antiserums for Identifying Viruses in Barley FC-ARS

Two antiserums were produced this year which makes it possible to identify two important virus diseases that attack barley. One of these viruses (barley stripe mosaic) causes marked reduction in yield, and the quality of the grain for malting purposes is reduced. The use of these antiserums will make it possible to distinguish one of the viruses from the other, and to detect virus-free plants and seed lots with a high degree of accuracy. This will speed up the process of producing virus-free seed stocks of the common varieties for farm production. There has been no change from last years' report which stated that yield losses



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from barley stripe mosaic are of the order of \$10,000,000 annually. This virus is carried in the seed from one year to the next, and no effective control measures have been found except to start with virus-free seed.

5. Yellow Dwarf Virus Disease of Barley

FC-ARS

Observations made during the year showed that the yellow dwarf virus disease of barley, which formerly was thought to be confined largely to California, now also is widely distributed in the barley areas of the North Central States, and is suspected to be present in the Rocky Mountain States and elsewhere. Thus, the losses from this virus are greater than reported last year. This virus can be transmitted only by aphids and the most promising measures for control are early planting and the breeding of resistant varieties. A few varieties which are tolerant to this virus have been found, but the search for varieties with greater resistance will be stepped up this fall when the entire world collection of 7,200 barley varieties will be screened for resistant sorts. It is very difficult to identify the yellow dwarf virus in the field because other factors also produce similar yellow symptoms. Work is under way to determine the possibility of finding an antiserum for this virus.

6. Insect Resistance in Plants

ENT-ARS

The resistance work is conducted in cooperation with the Field Crops Research Branch and the State agricultural experiment stations. In the cooperative investigations on European corn borer resistance sufficient evidence has now been accumulated to show that effective resistance can be readily recovered from crosses and synthetic varieties in which resistant factors have been incorporated. In the 1955 tests at Ankeny, Iowa, at least 14 advanced experimental inbred lines of regional origin showed effective resistance to first brood infestation in a single cross or common parent combinations. Several of the double cross hybrids under regional test by the corn breeders have corn borer resistant or tolerant lines in their parentage.

One phase of the cooperative program in Ohio has been directed toward increasing the resistance and improving agronomic qualities of the borer-resistant inbred line Oh45 that was released a few years ago. Selections have been recovered from a 3-way cross Oh45x (M14X CI 18702) that are more resistant than Oh45 and also possess more desirable agronomic qualities.

Two inbred corn lines designated as A295 and A286, which have shown a high tolerance to first-brood European corn borers, have been released by the Minnesota Agricultural Experiment Station. The selection of these two lines for corn borer resistance was done at Toledo, Ohio, during 1946-9 in a cooperative program between the Minnesota Station and USDA.

In the breeding program conducted cooperatively with the Cereal Crops Section and the Iowa Agricultural Experiment Station a large number of European corn borer resistant or tolerant lines have been continuously tested and selected through 6 or 7 generations of inbreeding. In 1955 this group consisted of 400 cultures representing 38 families. Effective resistance or tolerance occurs in all families. The primary sources of these lines are from crosses of synthetic varieties that contained known sources of resistance. A high proportion of these inbreds are undergoing agronomic tests in their respective maturity areas.

In cooperation with plant breeders of the Mississippi Agricultural Experiment Station a corn inbred out of the resistant single cross F44xF6 has been found to have considerable resistance to the corn earworm. This inbred when crossed with each of 7 testers and graded at three locations had an average of 10 kernels destroyed by earworms per ear as compared with 34 kernels per ear from the single crosses among the testers.

In cooperative studies with plant breeders at the Purdue Agricultural Experiment Station, inheritance of hessian fly resistance in crosses with the highly resistant variety P. I. 94587 has been determined by tests of 150 F<sub>2</sub> backcrossed families, 300 F<sub>2</sub> families, and several supplementary tests of parents and hybrids. In general these data indicated a simple inheritance and an easy transfer of P.I. 94587 resistance to soft red winter wheat. To date five genes for hessian fly resistance are known.

In the continuation of studies to determine resistance of wheat varieties to the hessian fly, 10,000 strains derived from many sources have been tested in the field and greenhouse. Thirty-four advanced unnamed lines in addition to the two released varieties Ponca, and Dual have shown a high degree of resistance to populations of hessian fly occurring in the winter wheat region.

Four races of hessian fly have been isolated from field populations at Lafayette, Indiana. The races are separated by their ability to infest certain wheat varieties. Intercrosses of the different races are being studied, and attempts are being made to develop adapted wheat varieties that are resistant to all races.

Dual, a new hessian fly resistant wheat variety developed jointly by USDA and Purdue University Agricultural Experiment Station was released for increase in 1955. Dual is the first Indiana-released wheat variety that is resistant to the hessian fly. It produces high yields when grown for grain and may be seeded before the hessian fly free date for pasture and forage production. In many tests over a period of 5 years, Dual has averaged 2.4 percent hessian fly infestation as compared with 55.8 percent for Vigo, a susceptible variety commonly grown in Indiana.

Basic studies in cooperation with cereal chemists to determine if any morphological characteristics of grain plants are responsible for resistance to hessian fly, showed a high positive correlation between hemicellulose content of the wheat plant and the degree of resistance to hessian fly attack.



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The protein, ash, cell sap, silica, and other trace mineral contents of the different wheat varieties were not correlated with resistance.

Approximately 1500 winter wheat hybrids and selections and more than this number of spring wheats were tested against the wheat stem sawfly at Minot, North Dakota, or Choteau, Montana. Two selections from Rescue x Chinock, two from Rescue x Regent, and one from Rescue x Thatcher showed a lower average percentage of stems cut than Rescue the resistant parent. In addition to these spring wheat hybrids at least four winter lines of Yogo x Rescue have shown considerable resistance and are in advance yield trials.

Continued investigations on wheat jointworms resistance in wheat have revealed four varieties showing a low degree of infestation. These are (1) Hard Federation - Mediterranean - Hope, from Kansas; (2) 55-5-1 Steintim - Thorne; and (3) PI 191436 from Field Crops Research Branch; and (4) Timopheevi hybrid x Chancellor, from South Carolina. At least one wheatlike agropyrum (agropyron x tritcum) known as Purdue A 39120 has indicated high jointworm resistance.

Several hundred early generation selections of barley hybrids involving crosses between greenbug resistant and adapted varieties have been tested for greenbug reaction in Texas and Oklahoma. From 15 to 25 percent of the F<sub>3</sub> lines were as resistant or more resistant than the resistant parents.

All of the resistance work will be continued and expanded whenever possible.  
(See Production - Proposals for Committee Consideration)

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#### 7. Chemical Control of Insects

ENT-ARS

Tests in Iowa showed that granular formulations of DDT continued to give better control of first-brood European corn borer larvae as good or better than emulsifiable formulations. Plants treated with DDT spray contained from 8 to 10 times more insecticide residue than plants treated with DDT granules. In the tests with granules high rates of application of low concentration formulations gave better borer kill than low rates of application of high concentration formulations. When properly applied 3/4 pound of actual DDT in granules was sufficient to give good borer control.

In laboratory screening tests against the European corn borer, two new chemicals, Bayer 17147 and DDVP have shown some promise. One hundred percent mortality was obtained of larvae feeding on corn leaves that had been immersed in 50 p.p.m. of Bayer 17147, or 100 p.p.m. of DDVP.

Experiments were initiated on the application of systemic insecticides to corn foliage, the soil around the plants and the corn seed before planting. None of the compounds tested in any of these experiments gave any borer control. There was, in fact, a trend toward more borers in plots sprayed with the systemics than in plots left unsprayed.

Good control of the corn earworm and fall armyworm on corn ears has been obtained by treating glassine "shoot bags" with insecticides. Bags treated with 5 percent emulsions of heptachlor, aldrin, chlordane, or



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DDT gave excellent protection to ears subjected to medium infestations where 84 percent of the untreated ears were infested, and very good control during a severe infestation were 97 percent of the untreated ears were infested. The use of treated "shoot bags" may be of value to corn breeders and to home gardeners.

Studies have been continued on the insecticidal control of soil insects attacking corn. In tests against the sugarcane beetle in corn, aldrin and dieldrin at one pound per acre have been slightly more effective than heptachlor at the same rate. Spray and granules appeared to be equally effective. The best control was obtained when application was made in a 6- to 8-inch band on top of the row after the corn had emerged.

Field plot tests in Alabama for the control of the white-fringed beetle in cultivated land showed that aldrin and dieldrin in granular and dust formulations applied in March 1953 at rates of 1, 2.5 and 5 pounds per acre gave above 99 percent control of the larvae in January, 1955. There appeared to be no difference in the effectiveness of aldrin or dieldrin or in the dust or granular formulations.

Tests in Alabama showed that dieldrin as a surface treatment was more effective against the white-fringed beetle than aldrin, chlordane, toxaphene, or DDT. A dosage of 5 pounds per acre gave complete kill for 2 years and 99 percent control the third year. Dieldrin at this rate was slightly more effective than the 50-pound dosage of DDT under the same conditions. Dusts were slightly more effective than sprays.

A larger scale grasshopper control experiment was initiated in Missouri for the control of crop-infesting species. A total of 910 acres of a 3000-acre area was sprayed during the normal hatching period with emulsions of aldrin, dieldrin, or heptachlor. All insecticides gave excellent control and no noticeable early damage occurred. However, there was sufficient infestation, either from late hatch or migration, in this area to cause damage in the late summer and fall to produce sufficient eggs for a potentially damaging infestation in 1956.

Investigations have been continued at the Stillwater, Oklahoma, station to find more satisfactory insecticides than those now in use for the control of the greenbug. One new insecticide, DDVP, gave a rapid knockdown but in the end was not as effective as parathion. Other insecticides have shown some promise against the greenbug but none have been superior to parathion.

Several of the new systemic insecticides have been tested as seed treatments for greenbug control. When American Cyanimid Compounds 12008, 12009 and 3911 at .5 pound per 100 pounds of wheat seed were compared with demeton at the same rate, it was found that 12008 and 3911 gave good protection from greenbugs for approximately 35 days and 12009 and demeton gave protection for about 25 days. Systemics when used as seed treatment in emulsion form reduced germination. The best method used was a slurry treatment with a 4 percent methocel sticker added to the systemic in activated carbon.

Parathion applied to wheat plots in Utah for brown wheat mite control gave highly significant yield increases of 6.4 to 8.4 percent. The treatments did not give high control indicating that higher yield gains could be obtained with more effective chemicals. In similar tests in Kansas yield of wheat was increased 26 percent by parathion treatments that gave a 75 percent control of mites.

Field tests in Oklahoma with acaricides against the brown wheat mite indicated that at .5 pound per acre American Cyanimid Compound 3911 and Diazinon were about as effective as parathion. Rohm and Haas Compound 293 also showed some promise, increasing significantly with time. With ground equipment an application of parathion as an oil solution at .5 pound toxicant and one gallon of oil per acre was slightly more effective against the brown wheat mite than the same amount of toxicant in 8 gallons of water.

Whemical control work on insects attacking grain will be continued.  
(See Production - Proposals for Committee Consideration.)

Publications:

The European Corn Borer and its Control, USDA Ent. Res. Br., ARS, Farmers Bulletin No. 2084, June 1955.

Ecology and Control of Soil Insects Attacking Corn in Illinois. J. H. Bigger, and R. A. Blanchard, Jour. Econ. Ent. 48(3) 255-60, 1955.

The European Corn Borer and its Control in the North Central States, North Central Regional Publication No. 22 (Revised), March 1955.

The European Corn Borer - A Situation Report, USDA, Ent. Res. Br., ARS 22-15, July 1955.

Timing Corn Borer Spray Applications, T. A. Brindley, H. C. Cox, W. G. Lovely, and T. A. Bancroft, Proceedings 10th Annual Meeting North Central Br. Ent. Soc. Amer. 11, 1955.

Recent Developments in European Corn Borer Control -- Granular Insecticides. H. C. Cox, Proceedings 10th Annual Meeting North Central Br. Ent. Soc. Amer. 11, 1955.

Seek Better Borer Control Methods. T. A. Brindley and co-workers. Your Experiment Station Report 1951-53. A Report of the Iowa Agricultural Experiment Station, pp. 7-8.

New Findings for Farm Folks, T. A. Brindley, W. G. Bradley, D. D. Questel, W. A. Lovely, et al, Iowa Farm Science 9(2) 1954.

Corn Earworm infestation in the North Central States in 1954 and Current Status of Control. R. A. Blanchard, Proceedings 10th Annual Meeting, North Central Branch Ent. Soc. Amer. 79-80.

Ecology and Control of Soil Insects Attacking Corn in Illinois. J. H. Bigger and R. A. Blanchard. Jour. Econ. Ent., 48(3) pp. 255-260, 1955.



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Biology, Control and Comparison of Mites Other Than Aceria Tulipae, attack wheat. C. F. Henderson, Report of the Seventh Hard Red Winter Wheat Improvement Conference 58-61, Jan. 1955.

Tests with acaricides against the Brown Wheat Mite. Charles F. Henderson and Elain W. Tilton, Jour. Econ. Ent. 48(2) 157-161, 1955.

#### 8. Insect Vectors of Wheat Mosaic

ENT-ARS

All insect vector work is conducted in cooperation with Federal and State plant pathologists.

With the discovery that a small eriophyid mite, Aceria tulipae, transmits the yellow streak mosaic of wheat, work has been concentrated on exploration for mite resistance in wheat. All commercial wheat varieties tested have been susceptible to the mite but several agropyron-wheat hybrids have shown a high degree of resistance.

Greenhouse tests conducted in Kansas indicated that the eriophyid mite could not be carried on the seed from the ripening head to the new seedling. Consequently, if volunteer wheat is not present in the field at harvesttime, other green host plants must be present to carry over the mite populations, and these plants might be important host plants in bridging the gap between the disappearance of mites from the ripening wheat head and the presence of volunteer or planted wheat seedlings.

Work on the transmission of plant diseases by insect will be continued.  
(See Production - Proposals for Committee Consideration.)

#### Publication:

Studies of Aceria tulipae in Kansas, R. V. Connin, Report of the Seventh Hard Red Winter Wheat Improvement Conference 66-67, Jan. 1955.

#### 9. Biological Control of Insects

ENT-ARS

Parasitization of overwintering European corn borers as determined from collections made from 12 States in the fall of 1954 varied from 0 to 26.2 percent. Parasitization was lower in New Jersey than in 1953 showing a decrease from 12 percent to 6 while in Iowa there was an increase from 9 to 14 percent.

The program of releasing parasites of the European corn borer in Minnesota, carried on for the past several years, was completed in 1955. Shipments totaling 6,455 adult Lydella grisescens R. D. were made which permitted releases in 12 counties not previously treated. The mortality of parasites during transit was only 0.4 percent. This work has been a cooperative project between Minnesota and the Federal government with financial assistance from Minnesota for the collecting of parasite material.

Preliminary field tests in Iowa using the fungus, Beauveria sp. for control of the first brood of European corn borers gave promising results. In three plots using sterilized corn meal as a granular carrier and growth

media for the fungus, the percent control of borers was 89, 91, and 93 or an average of 91. Three additional plots in the same experiments using attapulgitic clay granules as the carrier gave an average of 79 percent control. Moisture conditions which are essential for fungus growth were supplied by the plant, hence effectiveness was not dependent on climatic factors. Spray preparations were less effective than the granular materials.

Preliminary laboratory tests with a polyhedrosis virus have given promising control against the corn earworm, and a combination of polyhedrosis and granulosis virus has shown promise against the armyworm. A nematode has shown promise against several insects including the corn earworm.

Four specimens of a wheat stem sawfly parasite, Collyria calcitrator, introduced from Europe were recovered in June from an area in North Dakota. More than 6,000 of these parasites were released in this area in June, 1954.

Work on biological control of insects attacking grain will be continued.  
(See Production - Proposals for Committee Consideration)

#### Publications:

Notes on the Distribution of the European Corn Borer Parasite Perezia pyraustae and its effect on the Host. H. L. Zimmack, K. D. Arbuthnot, and T. A. Brindley, Jour. Econ. Ent. 47(4)

Parasites of the European corn borer found infesting the Stalk Borer, G. T. York, J. C. Schaffner, and T. A. Brindley, Jour. Econ. Ent.

Present Status of Parasites of the European Corn Borer. G. T. York. Proceedings 10th Annual Meeting, N. C. States Br., Ent. Soc. America, p. 65.

European Corn Borer Parasite Complex Near East Hartford, Connecticut, K. D. Arbuthnot, Jour. Econ. Ent. 48(1) 91-93, 1955.

Natural Enemies of the wheat stem sawfly in North Dakota and Montana. E. G. Davis, C. Benton, and H. W. Somsen, North Dakota Bimonthly Bulletin.

Notes on Parasitization of Grasshoppers by Nemestrinids. George T. York, Jour. Econ. Ent. 48(3) 328. 1955.

#### 10. Biology and Ecology of Insects

ENT-ARS

Studies have been continued by the Ankeny, Iowa, Laboratory in cooperation with several state entomologists on the interrelation of factors affecting control of the European corn borer. In 1955 early planted or taller corn was more severely infested with first-brood borers whereas the later planted or shorter corn was more heavily infested with second-brood borers. In connection with the experiments detailed records were taken on the life history of borers. When oviposition and hatching occurs over a long period of time the timing of insecticide application becomes more critical and it is difficult to obtain effective control with one application



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Surveys made in Utah and Idaho showed that the western bean cutworm was not a serious pest of corn in these states in 1955. Infestations were found in seven of 55 fields examined, but the infestation was not severe in any of the fields. This insect was found attacking corn for the first time in 1954.

In areas in Illinois where the corn rootworm is a factor in corn production it was shown that insecticidal control to prevent lodging was necessary only in land that had been in corn continuously for three or more years. In four fields where fall and spring plowing were compared there were on an average 786 more plants per acre in the fall-plowed than spring-plowed fields. Although the preceding crop and the method of cultivation had an important bearing on damage by soil insects, cultural methods could not be entirely relied upon for their control.

Studies made at Stillwater, Oklahoma, under drought conditions on the oviposition and larval habits of the southwestern corn borer, indicated that ovipositing moths showed a preference for green plant tissue but not for specific parts of plants. Early instar larvae were usually found in the tender moist tissue of whorls of young plants and in ear shoots of more mature plants. They moved from these sites and began tunneling into stalks while in the third and fourth instar. The transformation of larvae from spotted to overwintering stage was observed as early as July, indicating that this change is not always associated with the onset of cooler weather.

In studies of population densities in relation to economic damage by the wheat stem sawfly it was shown that a population as low as one-tenth female per square foot was sufficient to cause economic damage. Since under normal infestations the population is much higher than this any control measures, such as the use of chemicals, natural parasites and predators or cultural practices would have to reduce the population below this concentration.

Studies on the brown wheat mite in Utah were initiated during 1955. It was found that very few if any over-summering eggs hatched in the fall in Utah. Under Utah conditions in 1955 summer eggs started to appear almost as soon as active eggs became abundant. These conditions prevented the mite population from reaching highly economic levels. The key to the development of large populations of this mite appears to be in determining the factors that cause the production of over-summering eggs.

Studies will be continued on the biology and ecology of insects and this information will be used in developing more practical control measures.

#### Publications:

The Most Important Corn Insects. F. F. Dicke, Corn and Corn Improvement. Edited by George F. Sprague, Vol. V. of Agronomy pp. 537-612.

The Fall Population European Corn Borer Survey, T. A. Bancroft, T. A. Brindley, Robert Bowles and P. C. Tang, Iowa State College Jour. of Sci. 29 (1):61-74, 1954.

The Wheat Stem Sawfly - A Situation Report, USDA Agr. Res. Serv. ARS 22-13, April, 1955.

What's Being Done About the Wheat Stem Sawfly, P. Luginbill Jr., and F. H. McNeal, ~~Montanna~~ Farmer-Stockman, April, 1955.

Status of the Wheat Stem Sawfly in the United States in 1954. E. G. Davis, North Dakota Agr. Exp. Sta. Bimonthly Bul. Vol. XVII, No. 5 pp. 171-175, May-June, 1955.

Observations on Mass Flights and Other Activities of the Migratory Grasshopper, J. R. Parker, R. C. Newton, and R. L. Shotwell, USDA, Tech. Bul. No. 1109, April 1955.

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### C. FARM PRACTICES AND EQUIPMENT

#### 1. Weed Control

FC-ARS

Soft red winter wheat, spring oats, and winter barley were most tolerant to 2,4-D after the plants were tillered but before two nodes of the stem were visible above the rosette and again after the plants had bloomed until harvest. When 2,4-D was applied at rates normally used for weed control in small grains of weed-free wheat, oats, and barley at the most tolerant stages of growth, no significant injurious effects occurred. However, when 2,4-D was applied to these three cereals at susceptible stages of growth, yield was reduced, protein content was increased, germination percentage of oats was reduced and germination vigor of wheat was reduced. Germination of barley was not affected by low rates of 2,4-D. In addition, 2,4-D applied at high rates at susceptible stages of growth impaired the milling and baking quality of wheat.

Experiments in Missouri have shown that 2 pounds of 2,4-D per acre applied pre-emergence or 3 pounds per acre of 4,6-dinitro ortho secondary butylphenol (DNBP) applied post-emergence are approximately equal to one cultivation for weed control in corn. Sodium 2,4-dichlorophenoxyethyl sulfate (SES), 2,4-D (amine or ester), and the amine salt of DNBP applied as an early over-all post-emergence spray controlled weeds in corn under normal moisture conditions with no permanent injury to the corn.

Studies at Beltsville indicate that 2,3,6-trichlorobenzoic acid (TCB) is a promising pre-emergence herbicide for corn. At 1/2 to 1-1/2 pounds per acre, excellent control of grasses and broad-leaved weeds was achieved from planting until harvest, with little or no injury to the corn.

Reductions in yield of oats in New Jersey treated with 2,4-D are related to a reduction in the number of seeds per tiller with no evidence of reduction in number of tillers or weight of seed. Yields were reduced only when the 2,4-D was applied during the 2-3 leaf stage of development.

In Kansas an ester of 2,4-D was applied to Midland sorghum at 30 different stages of development at 1/2 pound per acre. The yield of crop was not affected by the herbicides until the crop was from 12 to 15 inches tall. From that stage of growth until the plants were heading, yield reductions, as a result of treatment, were serious. The most susceptible period, to damage from 2,4-D, appears to be at the time of transition from a vegetative to a reproductive plant.

#### Publications:

The effect of some chemical weed control treatments on the cultivation requirements of corn. O. Hale Fletchall. NCWCC Proceedings 11. 1954.

The effects of 2,4-D and MCP on sorghum. William M. Phillips. NCWCC Proceedings 11. 1954.

Results of bindweed control experiments at the Fort Hays Branch Station, Hays, Kansas, 1935 to 1952. William M. Phillips and F. L. Timmons. Kansas Agricultural Experiment Station Bulletin 366. 1954.



The effect of 2,4-D applied at different stages of growth and at different rates on the yield of Midland sorghum. William M. Phillips. NCWCC Progress Report 11. 1954.

The effect of 1/2 lb. 2,4-D Ester applied on 22 dates on the yield of Midland sorghum. William M. Phillips. NCWCC Progress Report 11. 1954.

The effect of 2,4-Dichlorophenoxyacetic Acid (2,4-D) on wheat, oats, barley and the legumes underseeded in these crops. W. C. Shaw, C. J. Willard, and R. L. Bernard. Ohio Agricultural Experiment Station Technical Bulletin 1954.

## 2. Grain Drying on the Farm

AE-ARS

The advantages of drying grain mechanically are well known to the Committee and need not be repeated. Research workers are pleased that, (1) there is continuing development and improvement in the manufacture of drying equipment for farm use; and (2) as one result of the progress in farm drying, the use of the field picker-sheller for corn is spreading rapidly and the grain combine is being adapted to harvesting shelled corn.

Work under way in AERB on farm drying of grain is directed at improving the effectiveness of the drying process and lowering costs. During the past year emphasis has been on (1) finding the effect of bin and duct design on the distribution of air flow in bins of drying grain, (2) finding the limits of drying time before spoilage begins in grains of various initial moistures under various temperatures; and (3) finding the rates of flow of unheated air that accomplish drying within the tolerable time limits. There has also been development of instruments for use in these studies.

## 3. Basic Studies of Air Flow Through Grain

AE-ARS

A method of estimating the pressure required to force air through grain when the flow is radial was developed, tested and published. Work is under way on similar estimates of pressure required when the air flow is along curved lines such as when multiple ducts are used. A new method of measuring the effectiveness of spaced air openings has been developed along with a new method of detecting differences in moisture content in drying grain. By applying these methods to one type of bin it was estimated that air openings two feet apart rather than continuous openings for admitting air resulted in a delay in drying some of the grain from 50 to 80 percent. This means that drying takes 50 to 80 percent longer. Since drying must be rapid enough to avoid the development of mold and spoilage it may not be practical to increase the drying time and it is necessary to either reduce the number of bushels in the bin or increase the air flow by larger fan and motor equipment. With this method of analysis, the penalty for poor air distribution in terms of decreased bin capacity or increased power and equipment costs can be weighed against the added cost of providing more air opening.

4. A New Type of Moisture Indicator

AE-ARS

A new type of electric moisture indicator developed in connection with this study is immersed in the grain during drying and indicates moisture without sampling or disturbing the grain. It is cheaper and smaller than other equipment and permits more detailed study of the moisture gradients resulting from poor air distribution.

5. Drying Grains with Unheated Air

AE-ARS

Studies are being continued at Ames, Ia., Holland, Va. and Athens, Ga. to determine the relationships between grain moisture content, atmospheric temperature and relative humidity and air flow requirements, for drying freshly harvested wheat, oats, shelled and ear corn and grain sorghum. Biochemists, botanists and entomologists of the Experiment Station staffs are cooperating in these studies to determine the presence and effects of mold and insect development on grain quality during and after drying. The data are studied in relation to typical weather conditions at harvest time of the respective grains, so that a fund of information on the requirements and feasibility of drying with unheated air under various climatic conditions is gradually being built up. Drying with unheated air at Holland, Va. is especially difficult because of the high temperatures and relative humidities occurring during the harvest seasons for all grains.

6. Cooperation With Farmers in Practical Tests

AE-ARS

The projects in Virginia and Georgia are cooperating with farmers in practical tests of drying corn and small grain with both heated and unheated air, and in developing buildings to meet crop drying and storage requirements in these areas. Requirements are different from those of the Middle West due to differences in climate and in type and size of farming operations. The farmer cooperators have been well pleased with the results as to effectiveness and cost of drying and reduction of insect losses in the grain stored after drying.

7. Pressures of Shelled Corn in Bins

AE-ARS

Measurement of pressures of shelled corn on the walls of a steel-walled flat storage building indicate that the pressure increased linearly with depth and corresponds to that of a liquid weighing 19 lbs. per cubic foot. This test did not confirm results of a test in a wooden bin reported in 1955 that indicated reduction in wall pressure near the bin floor. Apparently the measured reduction in pressure was due to slippage in the wall-to-floor connection of the wooden bin.

Further tests of pressures on exposed wall studs and flexible wall liners confirms that horizontal variations in wall rigidity are reflected in uneven distribution of wall pressures, with the most rigid areas of the wall supporting a large proportion of the total wall pressure. These relationships as well as pressures on vertically curved walls need further study to apply them to structural design problems. Tentative plans have been made to continue the pressure studies with other grains on seeds.



8. Discontinuance of CSS Participation in State Projects on Farm Storage of Grain AE-ARS

Allotment of CSS funds to ARS to aid grain storage studies in Ga., Ia., N. J., Tex. and Va. was discontinued as of June 30, 1955. CSS is continuing to loan equipment and grain to aid in carrying on these studies with State funds. These projects include studies of moisture migration in farm bins in Iowa, storage requirements of corn and small grains in Georgia, and New Jersey, drying of grain sorghum in Texas, and drying and storage of corn in Virginia. New Jersey also is testing use of large waterproofed bags as temporary storages for shelled corn.

Publications:

Revision of "Handling and Storing Soft Corn on the Farm" Farmers' Bulletin 1976.

Storage of Ear Corn on the Farm in the North Central States. Farmers' Bulletin 2076.

Wheat Storage Research at Hutchinson, Kans., and Jamestown, N. Dak. Technical Bulletin 1113.

Grain Drying with Unheated Air, W. V. Hukill. Agricultural Engineering, Vol. 35, No. 6, 1954.

Radial Air Flow Resistance of Grain, W. V. Hukill and N. C. Ives. Agricultural Engineering, Vol. 36, No. 5, 1955.

Non-Linear Air Flow in Grain Drying, W. V. Hukill and C. K. Shedd. Agricultural Engineering Vol. 36, No. 7, 1955.

The Influence of Crop Processing on the Importance and Design of Farm Buildings in Changing Agriculture, J. W. Simons. Presented at the Southeast Section Meeting, American Society of Agricultural Engineers, Louisville, Kentucky, Feb. 9, 1955.

9. Electric Seed Treatment for Smut Control AE-ARS

At Lincoln, Nebraska: Investigations have been continued to determine whether or not heating produced by high-frequency electrical fields might offer an effective treatment for the control of loose smut in barley. The work has been conducted in cooperation with the Agricultural Engineering and Agronomy Departments of the Nebraska Agricultural Experiment Station. The degree of smut infection in plants grown from infected seeds has been determined both in the laboratory and in the field. Microscopic examinations of seedlings in the laboratory have given almost exactly the same results as counts of smutted heads of plants grown to maturity in the field. The laboratory procedure provides the required information in a relatively short time and is very valuable for experimental work. Preliminary experiments using small quantities of seed have indicated that the electrical treatment of seeds previously soaked in cold water can destroy the smut.



However, germination has been considerably reduced. No control of the smut has yet been observed in experiments where the seed was not presoaked. Work is being continued with seeds of higher moisture content to discover whether the treatment might be successful without soaking the seeds before exposure to the electrical field. It will also be necessary to improve the efficiency of the treatment and perhaps to loosen the damage to germination if the method is to become practical.

10. Electric light Traps for Survey of Insect Populations AE-ARS

Some fifty electric light traps were installed early in 1955 in 14 States in cooperation with the Economic Insect Survey Section, Plant Pest Control Branch. These traps were installed northward from the Gulf to Iowa and Indiana. Catches of eight or more insects have been included in the Economic Insect Report each week since early March. These insects included the armyworm, fall armyworm, black cutworm, granulate cutworm, corn earworm, tobacco budworm, the tobacco and tomato hornworms and other special collections. Traps have been used as far north as Duluth, Minnesota and Maine to detect the report emergence of the armyworm north. Engineering efforts have been concentrated on improving the design of the trap itself to provide a device which would capture and destroy insects and retain them in satisfactory condition to be identified. A trap has been developed which meets these requirements satisfactorily under conditions of heavy rain and wind. Further improvement in moth attraction has been indicated in the operation of the black-light lamp, used as the attractant, at increased current ratings. Effects of such operation on life of the lamps as well as attraction will be determined in a continuation of this work.

11. Effects of Electromagnetic Radiation on Plant Yields AE-ARS

Limited exploratory experiments to observe the effects of radio-frequency electrical treatments on seeds have been conducted in cooperation with the Agricultural Engineering and Agronomy Departments of the Nebraska Agricultural Experiment Station. In conduct of other experimental work, a stimulation of germination has usually been observed in seeds receiving light to moderate treatments with high-frequency electrical fields. A field planting of corn using seeds with various degrees of treatment has shown an emergence from the soil of 94.5 percent for treated seed as compared to 90 percent for untreated seed. Drought conditions caused yield tests to be impracticable. The effects of radio-frequency energy on seed germination will be continued as a part of the study on insect destruction in grain and additional studies such as yield tests will be made dependent upon time and cooperative help available. Studies of plant variations among plants grown from similar seeds have caused many students to believe that seed characteristics are affected by electromagnetic radiation. The studies at Knoxville, Tennessee, conducted in cooperation

with the Agronomy and Agricultural Engineering Departments of the Tennessee Agricultural Experiment Station, are made by exposing seeds to electromagnetic fields of different intensities and of frequencies from continuous fields to frequencies of 4,000 megacycles. By using radiations in the lower frequency ranges, 60 cycles to 40 megacycles, observable differences have been produced on time of seed germination, water absorption of seeds, chemical changes in seeds, physical changes in seeds, and electric polarization. Attempts are being made to correlate certain electromagnetic radiation treatments with growth and yield data. Experiments are performed to determine what treatments (intensity levels and frequency variation) stimulate seed germination and what treatments inhibit germination. Such tests are made by germinating seeds in the laboratory. After the laboratory tests, seeds treated with selected ranges are planted in soil in the greenhouse for plant observation. During 1954 three levels of treatment at one frequency were used on corn which was planted in plots to determine whether different intensities affect the yield. (Results not available October 11, 1955) The equipment to provide wide ranges in frequency and intensity for treating seeds is now available. Time required to determine the effects is the limiting factor in progress of the work which will be continued.

12. Nitrogen Fertilization of Wheat in the  
Columbia Basin

SWC-ARS

The second year of a five-year study in the five Columbia Basin Counties of Oregon to determine the effect of fertilizers on wheat yield and quality and on the relationship of their response to soil properties, soil moisture, and rainfall was completed in 1955. In the 49 fertilizer experiments conducted in 1955 significant yield increases from Fall applied nitrogen were observed on 36 of 48 winter wheat experiments. Spring applied nitrogen increased yields on 42 farms. Yield decreases were obtained on five farms with Fall applied nitrogen. These farms were on shallow soils. No yield depressions were obtained with Spring applied nitrogen. Fall application was superior on 15 farms, spring application on 12, and no difference on 21. Wheat responded to phosphorus in two tests out of 48. This could be expected by chance. Response to sulphur was obtained in two tests. The amount of nitrogen required for maximum yields varied from site to site and no general recommendation can now be made. Nitrogen fertilization raised the protein content of wheat to desirable levels for pastry wheats. Protein was not raised to undesirable levels except by rates of nitrogen and excess required from that of maximum yields. This work was an excellent example of a cooperative endeavor among several agencies including the Experiment Station, The Extension Service, the Federally Supported Research group, the SCS and farmers. These studies will be continued for the next year at about the same level.

This work will be continued for one more year. Detailed soil and plant analyses will be made from all experiments. The work will be analyzed with respect to determining the relationships of moisture, nitrogen and climate as they affect yield and quality of wheat.



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Publications:

Hunter, A. S., Burr, J. A., Gerard, C. J. Annual Report 1954. Western Soil and Water Management Sections, SCS, ARS, USDA and Soils Department, Oregon Agricultural Experiment Station, Corvallis, Oregon, cooperating, March 1, 1955.

13, Irrigating and Fertilizing Crop Rotations SWC-ARS  
for Maximum Production

Farmers in the Huntley irrigation project produce less than one-half the yields obtained in a maximum rotation experiment conducted at Huntley, Montana. Results in 1954 indicate that continued high yields of corn, oats, beans, sugar beets and alfalfa are possible when proper combinations of fertilizer and irrigation practices are used. With the exception of sugar beets, crop yields have been twice as great on this rotation as those obtained from the project as a whole. A 5-ton increase in sugar beet yields above the average is the margin of difference between essentially no profit and a good economic return to the farmer. The results of this experiment point to the fact that soils in the Huntly project are capable of producing much higher average crop yields than those being obtained generally. Average grain yields in this location are: corn, 75 bushels; oats, 107 bushels; beans, 45 bushels; potatoes, 425 bushels; barley, 80 bushels per acre, from the maximum production rotation.

Similar experiments conducted at Grand Junction, Colorado on a site selected which was previously abandoned because of high water table and excessive salt conditions resulted in 105 bushels of corn per acre and over 50 bushels of barley with proper soil and water management practices.

Research on the effect of soil and water management practices on yield and quality of grain is being continued in Montana, Utah, Colorado, North Dakota and South Dakota.

Publications:

Amemiya, M., Evans, N. A., Robinson, C. W. and Hastings, M. N. Upper Colorado River Basin Investigations: Soil, water and crop studies. Western Slope Research, 1954, pp. 41-51, Colo. Agr. Exp. Station Gen. Ser. Paper #600. 1955.

Amemiya, M. and Hastings, M.M. and Colo. Agri. Exp. Station Staff. Soil, Water, and Crop Management Research Upper Colorado River Basin. Colo. Agr. Exp. Station Gen. Ser. Paper 586. 1954

14. Bloat in Ruminants APH-ARS

(a) Saponin Investigations - Studies of legume saponins (prepared by WURB) have been continued. Some of the studies have involved cooperation with personnel of the N. Y. State Veterinary College and of ADPRB. The toxicity of the saponin to sheep has been determined. The gross and



histological lesions resulting from toxic levels of the saponin have also been determined. Limited studies have been conducted to determine the pharmacological actions of the saponins when administered to sheep. Studies of the effect of saponin on ruminal motility and eructation have been conducted. It has also been shown that small amounts of alfalfa saponin can aid in the formation of the stabilization of frothy ingesta of ruminants, but that other factors are necessary for the production of frothy bloat in addition to the saponin.

(b) Feedlot Bloat Studies - Many of these studies, during the past year, have been carried out in cooperation with the University of Maryland. Rather detailed studies of the metabolic activity of the rumen microorganisms, as cattle were started on a bloat producing diet, were conducted. Studies have been conducted on the use of preventatives and treatments for frothy bloat.

Publications:

"Studies on Biochemical, Physical, and Bacteriological Factors Involved in Feed Lot Bloat," Don. R. Jacobson and Ivan L. Lindahl. University of Maryland Miscellaneous Publication No. 238, June 1955.

USDA Technical Bulletin, in preparation, "Alfalfa Saponins: Studies on Their Chemistry, Pharmacology, and Physiological Properties in Relation to Ruminant Bloat." APHRB, ADPRB, WURB, . and N. Y. State Vet. College.

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D. ECONOMICS OF PRODUCTION1. Production Adjustments on Wheat Farms

PE-ARS

Analyses are proceeding on the studies reported as being initiated last year in east-central Colorado, Columbia Basin area in Oregon, northern Montana, and north-central North Dakota, and work is planned in Kansas. Emphasis is being given to: (1) the economic feasibility of reseeding marginal and erodible lands to permanent grass; (2) improved management and cultural practices for alternative crops, grazing land, and livestock; (3) the size and type of farming situations in which each alternative enterprise is feasible; and (4) farming systems which will maintain soil resources. A progress report "Returning Cropland to Grass in East-Central Colorado," by Harry G. Sitler, Production Economics Research Branch, and Colorado Agricultural Experiment Station cooperating, was published in June 1955. It was found that it takes from three to five years, depending on weather conditions, to establish a productive permanent pasture in that area. With successful first seedings, cumulative earnings exceed cumulative costs by the end of the fifth and sixth year. If first seedings fail and second seedings become necessary, 10 to 12 years may be necessary to reach the "break-even" point.

2. Effect of Acreage Allotments on Land Use,  
Production and Income of Wheat Farms

PE-ARS

During July and August, 1955, farm surveys were made in west-central Kansas, North-central North Dakota, Palouse country of Washington-Idaho, and in northern Montana to gather data on individual wheat farms showing the changes in use of land, in production of wheat and other crops, changes in livestock programs, and the reasons for such changes. These data are being analyzed and will be reported to Congress by January 1, 1956. Further analyses are planned during the second half of fiscal 1955-56.

II. UTILIZATION RESEARCH (Progress Report)A. FOOD AND FEED USES, COMPOSITION AND HUMAN NUTRITION AND CONSUMPTION1. Nutrients in Grain Products

HN &amp; HR - ARS

Research on the B-vitamins in foods, including grain products, has been continued. The pantothenic acid content of foods was determined by laboratory analysis of market samples of 237 items (including 29 grain products) using the established, standardized procedure shown to yield reliable data as checked by bioassay. Data on these foods will be given in a report prepared for U. S. Department of Agriculture publication.

A wide range in the pantothenic acid content of grain products was found--from 0.4 milligram per 100 grams for vienna bread to 2.9 milligrams per 100 grams for all-bran cereal. A definite trend was evident--the less refined a grain product, the higher the vitamin content. Buckwheat flour and oatmeal were highest with 1.4 milligrams pantothenic acid per 100 grams, followed by whole wheat flour and grain with 1.1 milligrams per 100 grams; pearled barley and cornmeal and half the amount in wheat. The refined cereals and breads were from 14 to 60 percent lower than the least refined cereal, bread or the whole grain analyzed. Rye bread was comparable to white enriched bread. Two slices of white enriched bread or a shredded wheat biscuit contain a fourth the amount of pantothenic acid found in a medium egg or an 8-ounce glass of milk. Regarding other foods, on a fresh weight basis, liver and kidney were high in pantothenic acid, averaging 7.5 and 4.0 milligrams per 100 grams, respectively. Meats and poultry averaged 0.9 milligram; eggs, 1.6 milligrams; and nuts, 0.8 milligram per 100 grams. Research will be continued on the B-vitamins to determine the pyridoxine (B<sub>6</sub>) and cyanocobalamin (B<sub>12</sub>) content of foods by developing analytical methods that can be applied systematically in the analysis of all foods.

Tables of the amino acid content of foods are being developed, making use of data resulting in recent years from the application of suitable analytical methods. Grain products are among the foods included. The tables in preparation showing average values for 12 amino acids in important foods are urgently needed by the Department, nutritionists, and other groups concerned with the adequacy of the protein quality of food supplies, including the National Research Council's Committee on Amino Acids. They will permit a fairly good estimate of the amino acid content of the per capita food supply, of family diets, and of the food intake of individuals, and will show the contribution of various foods (including grain products) to the supply of each amino acid.

Publications:

Source of Error in Microbiological Determinations of Amino Acids on Acid Hydrolysates. II. Apparent Loss of Amino Acids on Storage, M. J. Horn, A. E. Blum, C.E.F. Gersdorff, and H. W. Warren, Cereal Chemistry 32: 64, 1955.



2. Human Nutritional Requirements

HN-ARS

Research in the field of human nutritional requirements is continuing to contribute information basic to evaluating the use of grain in planning nutritionally adequate diets.

Coordinated research on amino acid requirements under contract with three institutions is providing the first metabolic data indicating the probable requirements of women for eight of the essential amino acids all of which are present in the proteins of grain. The data are being used this year by a joint FAO/WHO Expert Committee meeting in Rome to consider the protein needs of world populations.

In addition, investigations on the influence of dietary carbohydrate on amino acid requirements using laboratory animals are contributing information basic for planning diets adequate in protein. With restricted protein intake, diets containing corn dextrin or the starches of corn, rice or wheat tend to lessen the amount of amino acids required to maintain nitrogen balance and to lessen the amount of liver fat deposited as compared to diets containing sucrose as the sole carbohydrate.

One phase of research to determine the requirements of B-vitamins for normal individuals of different ages has been completed through studies of the thiamine and riboflavin requirements of adolescent boys. Investigations under contract, using eight healthy boys 14-17 years of age, resulted in an estimated daily requirement for this age group of 1.36 mg. of thiamine or 0.38 mg. per 1200 calories and 0.30 to 0.35 mg. riboflavin per kilogram body weight. Enriched or whole grain products are a good source of both of these vitamins.

The results of the investigations on amino acid requirements will be prepared for publication. Data from investigations on the thiamine and riboflavin requirements of young children and of older women will be evaluated and prepared for publication.

In connection with this research, the following proposals have been presented for consideration by the Food and Nutrition Advisory Committee:

Expand research on the effect of type of carbohydrate in the diet on amino acid utilization to include other components of diet, and other biochemical and physical criteria of the nutritional effects.

Initiate research to investigate the role of fat in human nutrition such as the relationship of the amount and kinds of fat to metabolism of other nutrients, determination of desirable upper and lower limits of fat intake in various nutritional situations, and the dietary precautions needed when fat in diets is unusually high or low.

Expand research on the effect of diet on adult efficiency and premature physical impairment in laboratory animals to include more intensive observations on the nature of the impairment encountered under conditions of recent experiments and the elimination of the nutritional imbalance involved.

Expand research to determine the physiological availability of nutrients from foods, and the extent to which food processing, other food constituents and diet patterns affect their availability.

Publications:

The amino acid requirement of young women. IV. Pexnylalanine. R. M. Leverton, N. Johnson, J. Ellison, M. Skellenger, T. Geschwender, and F. Schmidt. Federation Proceedings 14, 441, March 1955.

Methionine and Lysine Requirements of Mature Women. E. M. Jones, C. A. Baumann, and M. S. Reynolds. Federation Proceedings 14, 438, March 1955.

Estimation of Thiamine Allowances for Adolescent Boys. Janice M. Smith, Shih-Dzung Chen, M. H. Bert, and Edna Dick. Federation Proceedings 14, 450, March 1955.

3. Food Consumption Surveys

HE-ARS

The 1955 Food Consumption Survey (cooperative with Agricultural Marketing Service) will show quantities of foods used by population groups, such as urban and rural families in different income and regional groups. All foods are covered, including grain products. Such surveys also make possible estimates for the proportion of families with diets not meeting nutritional recommendations and show the economic and nutritional significance of foods (including grain products) in the diet. Collection of data from a nationwide sample of about 6,000 families has been completed and processing is now underway.

Completed during the year were two publications of findings from earlier surveys. One, reported last year, has information on household practices in the preparation and use of foods (including grain products) in 3 cities; the other is the first of two reports on a rural food consumption survey in the North Central States.

Publication plans for the 1955 Food Consumption Survey call for a preliminary report early in 1956 of data on total family food expenditures. During 1956, a series of regional-urbanization reports on the details of household food consumption will be released. These reports will be similar to the first of the series of preliminary reports issued on the 1948 urban food consumption survey, and will show quantities used and expenditures for different kinds of foods (including grain products) insofar as it is possible to publish the details. Preparing these and other basic data from the food survey for release, including estimates of the nutritive content of family food supplies, is expected to take the major portion of staff time assigned to this area of work for the next two years and the amount of additional analytical work that can be undertaken during this period with existing staff is limited.

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Publications:

Household Practices in the Use of Foods, Three Cities, 1953. C. LeBovit and F. Clark. AIB-146 (In press).

Food Expenditures, Home Production and Food Preservation, Rural Families in the North Central Region, 1951-52. (Report I of Survey in 12 States). M. Orshansky, E. C. Blake, and M. A. Moss. AIB- (In press).

4. Basic Information for Food and Nutrition Programs HE-ARS

Simplified material on the essentials of an adequate diet, in terms of everyday foods, is being developed. Knowledge of nutritional requirements, and how they may be met by foods, needs to be applied more effectively in the many programs of teachers, nutritionists, Extension workers, and others who are trying to promote effective use of foods for nutritional health. Using data on nutritional needs, the composition of foods, the potential contribution of various groups of food to the diet, a basic food guide is being developed with supplementary material to show how to attain flexibility in its application to different food supplies, food habits and for different groups of persons.

Before publication, the manuscript is being submitted to interested groups for comments and for suggestions for popular presentation. The food guide will be completed and made available for use in different forms to suit various users.

5. Facts for Consumer Education HE-ARS

A publication on bread in the series on Facts for Consumer Education is now in press. This publication based on evaluation of data from many sources was designed as a basic reference and source material for those preparing material for educational programs. Contents include information on consumption, nutritive value, production and marketing practices, buying tips and care in the home.

Publications:

Bread--Facts for Consumer Education, AIB-142 (In press).

6. Identification of Flavor Constituents in Bread WU-ARS

In order to provide bread with the optimum desirable fresh flavor to consumers, a project has been undertaken to identify and measure the constituents responsible for bread flavor. The possibilities that liquid-ferment and continuous-mixing processes offer for improving bakery operations, and that freezing offers for preservation of freshness, have increased the need for such information and the likelihood of its eventual practical application.



The first phase of this project has included the design and development of apparatus for the separation of micro amounts of volatile materials found in bread. The apparatus employs a new technique, known as gas chromatography, which currently is being rapidly developed and widely applied to the separation of compounds not readily separated by other procedures. Separation of the volatile materials from bread, by this new technique, confirms the complex nature of bread aroma. At least sixteen individual components have been observed; several of these, on the basis of tentative identifications, have not been reported previously to occur in bread. This study will be continued along the same line.

7. Sulfur-Containing Amino Acids of Wheat Proteins

WU-ARS

Much experimental evidence has indicated that the sulfur-containing amino acids of wheat flour proteins strongly influence the baking properties of flours, but the available information is not sufficiently precise or extensive to be used in wheat processing to maintain and improve the quality of products. Therefore, studies were undertaken to determine chemical characterization of the sulfur-containing amino acids in various wheat proteins. The chemical reactivity of some of the sulfur-containing groups of wheat proteins appears to differ from that of other similar groups in other proteins. It has been suggested that this difference may result from a chemical relationship of sulfur to phosphorus in these components.

In the first stages of this work, therefore, as various flour protein fractions were isolated, the occurrence of phosphorus as well as sulfur was determined. Protein containing phosphorus was found in gluten to a relatively small extent. Efforts to concentrate the portion of the protein which includes phosphorus have yielded material containing more than 1 percent phosphorus (as well as considerable sulfur). The separated material resembles an albumin (water soluble) protein rather than a gluten protein, however; and the nature of the phosphorus, and particularly whether it is linked directly with sulfur, remains to be determined. The isolation procedure presently in use yields quantities of the preparation differing in amount by at least four-fold between flours from different classes of wheats, and this may indicate significant differences in the protein composition of the flours. This work will be continued to improve the isolation procedure for this unusual type of protein, and to determine its properties, including effects on baking properties.

8. Lysine, An Essential Amino Acid, in Wheat

WU-ARS

Wheat and wheat products, in common with other cereal grains and their products, are known to contain too little of certain of the nutritionally-essential amino acids for proper maintenance of mature animals and particularly for the normal and rapid growth of young animals. The greatest such deficiency apparently is in lysine content. The lysine content of wheats of widely-varied types and parentage and of related genetic types is being determined under a research contract by the State College of Washington to ascertain whether wheats with a higher content of lysine than presently-grown varieties are available. Such wheats could be used by

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wheat breeders to impart this characteristic to new varieties that would command a broader market either for human food or for animal feeds. Samples have been collected and a suitable reliable and accurate assay method for use on grain products has been developed. This work will be continued through analysis of the collected samples.

9. Protein-Lipid Combinations in Wheat Farmers WU-ARS

Work in this field was resumed during the past year. Previous observations in several laboratories have shown that the lipids (fats and fat-like compounds) in flours affect their baking and keeping qualities, presumably through association with the flour proteins. The total effects of the lipids have not been demonstrated, however, because no method has heretofore been available for removing all the lipids from flours without damaging the proteins. A method for extracting lipids has now been developed which apparently does not damage proteins with which they are associated.

This method of extraction shows considerable promise for analytical purposes. Furthermore, after extraction the gluten proteins retain their cohesive and elastic properties with little change in solubility, and the gluten can be washed from extracted flours. This work will be continued to determine the baking characteristics of lipid-free flours and the effects of lipids on baking properties.

10. Composition, Structure, and Properties of Cereal Grains and their Components NU-ARS

Research on composition, structure, and properties of cereal grains and cereal grain constituents is needed to provide basic information for use in improving and extending the utilization of cereal grains through the development of new processes and products and the more efficient use of cereals as feed grains.

(a) Degermination of Corn --Cementing Layer between Corn Germ and Endosperm - Improved processing of corn in the dry-milling industry with greater recovery of valuable byproduct corn oil would result if better separation of germ from endosperm were effected. Investigations basic to this problem have been initiated with a study of the composition of the cementing layer between the germ and the endosperm in the corn kernel. A small amount of the material which comprises this extremely thin layer (less than 0.001 inch thick) has been separated and more is being obtained by dissection under the microscope. Meanwhile, qualitative studies have been made of the material in its natural position (in situ), in sections of the kernel, which indicate that the cementing layer contains little, if any, cellulose and hemicelluloses, but that some protein material and pectin are present. Quantitative studies will be started when sufficient amounts of the cementing substance have been separated for analysis. This work will be continued to confirm present findings and to identify further constituents and determine their relative amounts.



(b) Compounds Responsible for Odor and Flavor in Corn - A major factor restricting the wider use of corn and corn starch as food material is its distinctive odor and flavor. Removal of flavor and odor from corn and corn starch would be favorable to its increased use in a number of applications, as for example, in pudding mixes, in the production of special sirups and adhesives where absence of flavor is important. Under a research contract, the University of Iowa has started work on the separation and identification of substances contributing to the characteristic odor and has developed an improved process for isolation of a concentrate of the odorous fraction from corn germ. Preliminary analyses of two crude fractions for carbon and hydrogen and by infrared spectroscopy indicate that the main compound or compounds present may have relatively few chemically reactive groupings. This work will be continued to further separate, purify, and identify the odoriferous compounds.

(c) Nutrient Composition of Grain - Comprehensive, up-to-date information on the nutrient composition of grain compiled in readily accessible form is essential to the best utilization of grain in conjunction with other feeds in animal rations. To provide this information, work is in progress by the National Research Council, under a research contract, on the collection, interpretation, and compilation of tables of nutrient composition of cereal grains and forages based on a comprehensive search of the literature and solicitation of unpublished data from experiment stations, feed industry laboratories, and similar laboratories. To date 18,000 sets of analyses have been collected, providing compositional data for over 50 nutrients including vitamins, amino acids, and trace minerals.

Compositional data, together with available information on location grown, variety, commercial grade, and maturity, have been coded and will be transferred to IBM cards to facilitate summarization and compilation of tables of representative composition.

(d) New Uses for Corn -- Corn of High Amylose Content - Work has continued on promoting the development of strains of corn having starch of high amylose content in cooperation with Field Crops Research Branch of ARS and with commercial corn breeders. The amylose component of starch is of considerable interest because of its potential usefulness in the preparation of fibers, plastics, and edible-type films for use in food packaging. During the past year, analyses of starches from 369 new crosses showed the highest amylose content to be 67 percent. This is to be compared with ordinary field corn with starch of about 27 percent amylose content. This work is being continued in an effort to develop corn with 80 percent or more amylose in the starch, the minimum estimated necessary for generally desirable film properties.

(e) Uses for Corn Hull -- Chemical Structure of Plant Gums - Chemical modification of cereal starches to impart properties similar to those of imported natural gums requires information on the structural features which contribute desirable properties to the gums. As a first step in providing this information, a comprehensive study has been made by the



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University of Minnesota, under a research contract, of all published structural information on the natural gums and correlation developed between structure and physical properties. Although only broad generalization could be drawn because of the limited chemical information, it appears that gum-like properties are characteristic of high molecular weight polymers having a branched molecular structure. Structural differences resulting from the occurrence of different kinds of sugar units, for example, or a variety of branch lengths or limited numbers of electrically charged groups, apparently contributes to gum properties. Experimental verification and expansion of these generalizations now are being sought through chemical studies of the structure of a gum-like hemicellulose isolated from the hull fraction of corn and which has potential industrial value as a gum. First indications are that this corn hull hemicellulose may contain four or more different sugar units and that the molecule has a highly branched structure. This work will be continued to include comparative structural studies on a plant gum of recognized high quality.

(f) Physical Properties of Natural Starches - Basic studies are in progress on the sizes, shapes, and the range of molecular weights of starch molecules or molecular aggregates that exist in water dispersions of starch comparable to those that are used industrially. Information on these characteristics of starch dispersions will aid in establishing a basis for improvement of industrially important physical properties of starch such as paste viscosity and gel strength which make starch useful yet are incompletely understood. Size of molecular aggregates in corn starch dispersions has been shown to vary markedly with dispersion conditions, decreasing with increasing time, temperature, or shear imposed by stirring. The proportion of starch in solution was shown to increase under the same conditions, thus explaining the higher specific viscosity values observed for dilute solutions of starches dispersed under more drastic conditions. Application of high shear rates by forcing suspensions through small orifices was found to disperse starch rapidly and produce a relatively narrow range of particle sizes in solution. This homogenizing action on a molecular scale is probably also produced by the shearing action of colloid mills recently introduced into the starch-consuming industries and explains some of the desirable properties of resultant starch dispersions. Based on the difference in sedimentation rates of the linear (amylose) and branched (amylopectin) molecular components of starch observed in these studies, a centrifugal method was developed for separating these components in corn starch solutions. Subfractions of the principal components also are separated by the new method. This work should be expanded to characterize further corn starch dispersions and to investigate properties of other cereal starches. (See Utilization - Proposals for Committee Consideration.)

(g) Physical Microscopic Structure of the Hard Wheat Kernel - Gross structure of the Hard Red Winter wheat kernel, discussed briefly in last year's report, has been studied in detail using microscopic techniques, with emphasis on relationship of the various parts to one another. A paper describing this work, illustrated with photomicrographs, has been prepared giving special attention to industrial significance of structure

such as possible paths of entrance of water into the kernel during conditioning for milling, and interpretation of the cleavage and separation of structural components which occur during milling. Three succeeding papers are planned which will, respectively, emphasize the detailed structure of the individual parts of the wheat kernel -- the germ, bran, and endosperm. Work on the details of germ structure is nearly completed, and considerable progress has been made in investigation of the other two portions. This information will provide grain processors with detailed knowledge of the structure of the raw material with which they work. Microscopic study of the structure of the Hard wheat kernel is expected to be completed during the coming year.

Publications:

The Structure of Ampha-Amylase Modified Waxy Corn Starch. R. L. Lohmar. J. Am. Chem. Soc. 76(18): 4608-4611 (1954).

Studies on the Effect of Drying Conditions upon the Composition and Suitability for Wet Milling of Artificially Dried Corn. M. M. MacMasters, F. R. Earle, H. H. Hall, J. H. Ramser, and G. H. Dungan. Cereal Chem. 31(6), 451-61 (1954).

X-Ray and Photomicrographic Examination of Rice. Joseph T. Hogan, R. A. Larkin, and M. M. MacMasters. J. Agr. Food Chem. 2(24): 1235-39(1954).

A Partial Survey of Amylose Content in Starch from Domestic and Foreign Varieties of Corn, Wheat, and Sorghum and from Some Other Starch-Bearing Plants. W. L. Deatherage, M. M. MacMasters, and C. E. Rist. Trans. Am. Assn. Cereal Chem. 13(1): 31-42(1955).

The Structure of a New Starch of High Amylose Content. I. A. Wolff, B. T. Hofreiter, P. R. Watson, W. L. Deatherage, and M. M. MacMasters. J. Am. Chem. Soc. 77(6): 1654-59 (1955).

Extracting Hemicelluloses. Michael J. Wolf, John A. Cannon, and Majel M. MacMasters. U. S. Patent 2,709,699. May 1955.

11. Oats of Higher Vitamin Content

NU-ARS

First progress on work directed toward improving the nutritional value of oat grains by selectively crossing strains for higher niacin, riboflavin, and protein content was reported last year. These studies under an information memorandum of understanding with the Iowa State College have been continued. After it was demonstrated quantitatively that niacin and riboflavin and perhaps protein are under genetic control, i.e., inherited, indicating the possibility of increasing these constituents, additional parent and progeny strains were crossed and their seeds analyzed. Statistical analysis of the data from about 500 samples of grain showed some association of the protein and niacin factors. One of the more practical aspects of the data obtained concerns the dominance of high riboflavin and niacin contents in oat crosses. It seems possible that oat

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varieties can be produced with a much higher niacin or riboflavin content than those now being grown. The heritability characteristics of niacin are encouraging since they indicate that selection for breeding for this vitamin should be effective. The dominance for high or low protein percentage seems to depend upon the genetic background of the particular oat cross. Data show that in two crosses high protein percentage appears to be dominant. Solution of the problem of selecting for protein content awaits the production and analysis of grain from additional crosses. To obtain this information it is planned to have various new crosses made with seed from various sources including parent stock in the World Oat Collection at the Iowa State College.



B.

B. QUALITY PRESERVATION AND DEVELOPMENT OF NEW AND IMPROVED PRODUCTS AND PROCESSES1. Bread Staling

NU-ARS

Staling of bread results in large losses to the baking industry in the form of stale returns and also contributed to the continual decrease in annual per capita consumption of wheat in bakery products by decreasing their palatability and thus consumer acceptance. Changes in bread constituents which occur during staling are understood but poorly today. In work undertaken by the American Baking Institute, under research contract, to determine the role of starch in bread staling, studies have been made of the effect of modified starches and starch-degrading enzymes on the staling rate. It was found that substitution of a nongelatinizing starch for wheat starch in flour gave an initially firmer loaf but decreased staling in the resultant bread as measured by changes in firmness of the crumb. This indicates that wheat starch in ordinary bread contributes to bread firming on aging. This result was supported by experiments in which heat-stable, starch-degrading enzymes were added to the dough before baking. Firming changes subsequent to baking were progressively decreased as the proportion of enzyme was increased; the crumb, however, became undesirably gummy as a result of excessive breakdown of the starch. Addition of heat-stable enzyme combined with replacement of part of the wheat starch by a nongelatinizing starch (enzyme resistant) produced a loaf with little or no increase in firmness in the period from 20 to 140 hours after baking. Taste panel evaluation of this bread showed little decrease in acceptability over a similar period, rating it fresh at 140 hours. This work will be continued with further tests to conform and extend present results.

Publications:

Recent Progress in Studies of Bread Staling. M. M. MacMasters and P. D. Baird. Baker's Digest 28(5): 92-95, 103 (1954).

The Bread Staling Problem. Molecular Organization of Starch upon Aging of Concentrated Starch Gels at Various Moisture Levels. N. N. Hellman, Barbara Fairchild, and F. R. Senti. Cereal Chem 21(6): 495-505 (1954).

2. Relationship Between Moisture Content and Relative Humidity of Wheat and Corn

NU-ARS

Studies on pure varieties of wheat representing five classes of midwestern and western wheats at three temperatures were previously reported. Additional samples from commercial lots of wheat representing five midwestern classes have been studied with an electric hygrometer. Results checked those previously obtained with the pure varieties. The effects of age and location were investigated and an analysis for significance of the results is being prepared.

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In the region of 15 percent moisture content, which is near the critical level for mold growth, it was found that wheat of 15 percent moisture content may be in equilibrium with air varying from 72 to 79 percent relative humidity. Conversely, wheat in equilibrium with air of 75 percent relative humidity may show moisture contents as low as 13.6 and as high as 15.5 percent at 30° C. Results similar to those mentioned for wheat also were obtained on corn.

It is common knowledge in the grain trade that some lots of grain will spoil and others will not when stored at 15 percent moisture. This is undoubtedly due, in part, to migration of moisture within the grain mass due to temperature differential resulting in regions of higher-than-average moisture content, but it is possible that the hysteresis effect might be a factor.

On the basis of these laboratory findings then, it is evident that the variation in relative humidities at the same moisture content may in part explain the incidence of mold growth in grain considered to be a "safe" moisture level.

The project on wheat has been discontinued and the studies on corn have been completed.

### 3. Microbial Feed Supplements

NU-ARS

Notable improvements have been made in the efficiency of livestock and poultry feeds through the use of vitamins, antibiotics, and protein material of microbial origin. For example, the Northern Branch has discovered organisms and developed commercial fermentation processes which among others are now used in the manufacture of riboflavin and vitamin B<sub>12</sub>. These developments suggested the possibility of discovering microorganisms which would produce a feed supplement containing both vitamin B<sub>12</sub> and antibiotic in a single fermentation and of finding microorganisms which would provide a rich source of certain essential amino acids for the enrichment of the rations of farm animals.

(a) Vitamin B<sub>12</sub> Antibiotic Feed Supplement - In May 1954, an organism, Streptomyces sp., NRRL B-1354, and a fermentation process for producing a feed supplement containing vitamin B<sub>12</sub> and antibiotic were released for public use. Information about the process and composition of the product were given in last year's report. During the current year, considerable interest was shown in this development by a number of commercial firms and assistance was given them by providing cultures of the microorganisms, samples of the feed supplement, and information about the fermentation process. As a result of this work, one firm is now manufacturing a growth stimulant named "Ferma-Gro" with NU's organism. This fermentation product improves growth and feed consumption of broilers and turkeys. The favorable results obtained by the Michigan State University from contract and cooperative feeding trials on chicks with the products of NU and this commercial firm have been confirmed by independent nutritionists.



(b) Microbial Proteins with High Contents of Essential Amino Acids - In view of the shortage of certain essential amino acids, especially methionine, lysine, and tryptophane, in rations for swine and poultry, a survey of microorganisms for strains producing protein usually rich in these amino acids is in progress. Approximately 400 representative strains of yeasts and molds from the NU Culture Collection have been grown and analyzed, with the following results:

	<u>Lysine Percent</u>	<u>Methionine Percent</u>	<u>Tryptophane Percent</u>
Yeasts (240)	4.0-9.5	0.5-1.6	0.8-1.8
Molds (165)	3.0-5.5	0.6-2.6	0.3-1.5
(For comparison, the percentage of these acids in the protein of meals, is cited.)			
Soybean Oil meal	6.3	1.4	1.3
Corn gluten meal	1.7	2.2	0.5

It is expected that, because of the wide range in content of amino acids found in the protein of these organisms, still higher amino acid contents will be encountered as the survey continues.

Attempts to change the amino acid composition of the microbial cell proteins by ultraviolet-induced mutations show that the concentration of the sought-for amino acids can be raised approximately 20 percent. Similar increases in the amount of methionine, lysine, and tryptophane in the cell proteins apparently can be brought about by suitably altering the propagation conditions.

The survey of microorganisms will be expanded to include more strains from the most promising groups of yeasts and molds as well as representative strains of bacteria. Efforts to increase the content of certain amino acids in the cell by mutation techniques and change in the propagation conditions will be continued. When a suitable product is obtained, feeding trials will be arranged with agencies which have experimental animal facilities.

#### Publications:

Fermentor for Small-Scale Submerged Fermentations. Robert G. Dworschack, Adolph A. Lagoda, and Richard W. Jackson. Appl. Microbiol. 2(4): 190-197 (1954).

The Use of Distillers Dried Solubles and Some Other Supplements for the Production of Biologicals. Harlow H. Hall. Proceedings of the 10th Distillers Feed Conference, Cincinnati, Ohio, March 3, 1955. pp. 15-21. (1955)



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4. New Antibiotics to Combat Plant Diseases

NU-ARS

The discovery and development of new antibiotics for the prevention and/or control of plant diseases would do much toward improving the quantity and quality of important crop plants and would lessen the annual 3 billion dollar loss due to plant diseases. Preliminary studies have established the fact that there are good possibilities, through fermentation research, for discovering microorganisms which produce new antibiotics useful for plant disease control. This research has been intensified during the past year.

More than 500 strains of actinomycetes were tested in the laboratory to determine their abilities to produce antibiotics which would inhibit selected plant disease bacteria and molds. Thus far, two or three dozen strains have shown promise. These have been grown in liquid media, and the antibiotic-containing liquors, or crude products obtained therefrom, have been tested by the Horticultural Crops Research Branch against nine diseases in greenhouse-grown plants. The majority of the materials tested in the greenhouse were found to prevent or control at least one of the nine plant diseases. One strain has shown considerable promise. Its culture liquors were found under laboratory greenhouse conditions to control bean rust, bean anthracnose, bluegrass powdery mildew, and wheat stem rust. Research on this strain was extended to include the determination of optimal conditions for production of its antibiotics as well as chemical work on the stability and isolation of the antibiotics produced. At least four antibiotics are produced by this strain and efforts are now being made to determine which antibiotic or combination of antibiotics is responsible for the activity of culture liquors in controlling plant diseases.

Future investigations will be directed toward more intensive study of these antibiotics and the development of practical methods for the use of crude products, such as spray-dried culture liquors, for control of plant diseases. Testing of additional actinomycetes will continue and promising strains will be subjected to extensive developmental studies.

Publications:

Useful Criteria for Species Differentiation in the Genus Streptomyces.  
C. W. Hesseltine, R. G. Benedict, and T. G. Pridham, Annals N. Y. Acad. Sci. 60 (1): 136-151 (1954).

5. New Research and Service of the Culture Collection

NU-ARS

The Culture Collection is concerned with the isolation, maintenance, and distribution of industrially important microorganisms in pure culture for use in the manufacture of antibiotics, enzymes, vitamins, animal feed supplements, and organic acids. Exclusive of the hundreds of cultures supplied for NU's investigations, 2,166 cultures were furnished last year to other laboratories and to companies. Four hundred and twelve cultures have been identified and 232 new species or strains of microorganisms have been added to the permanent culture collection within the last year.

Investigation of a new pigment-forming bacterium, Pseudomonas aureofaciens, has revealed the identity of the pigment and has shown that it possesses inhibitory activity against some pathogenic microorganisms. An investigation has been completed involving the members of the genus Thamnidium which is noted for its regular occurrence on cold stored meat. Taxonomic studies indicate that all members belong to four species, one of which is new to science.

Heterokaryons, hybrids formed vegetatively between two molds, have been made by the University of Wisconsin under a research contract. These hybrids are from color mutants derived from a superior citric acid producing Aspergillus niger culture. It was hoped that such hybrids might produce superior yields of acid. Laboratory tests showed a wide range of yields of acid, but more importantly they showed that the heterokaryons are unstable genetically and a method must be devised to insure their constant stability necessary for best yields.

Future work will involve taxonomic study of additional members of the mold group Mucorales and further investigation of the pigmented Pseudomonas cultures. Studies will be continued in the yeast genus Hansenula and related yeast forms with particular reference to their biochemical and mating activity. All of these forms are of multiple interest in the utilization field and related agricultural fields.

#### Publications:

A Clarification of the Relationship of Candida guilliermondii to other Yeasts by a Study of their Mating Types. Lynferd J. Wickerham and Kermit A. Burton. J. Bact. 68(5): 594-597 (1954).

The Effect of Potassium upon the Growth of Micrococcus pyogenes. W. C. Haynes, Ralph W. Kuehne and Lenora J. Rhodes. Appl. Microbiol. 2(6): 339-344 (1954).

The Influence of Incubation Temperature upon the Growth Response of Micrococcus pyogenes to Potassium. W. C. Haynes, R. W. Kuehne and L. J. Rhodes. Bact. Proc., p. 47 (1955).

Taxonomic Studies on Streptomyces with Particular Reference to Blue, Blue-Green and Green Spored Isolates. T. G. Pridham, Patricia Anderson and C. W. Hesseltine. Bact. Proc., p. 28 (1955).

Genera of Mucorales with Notes on Their Synonymy. C. W. Hesseltine. Mycologia 47:344-363 (1955).

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The genus Circinella. C. W. Hesseltine and Dorothy I. Fennell. Mycologia 47: 193-212 (1955)

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New species and varieties of *Aspergillus*. Dorothy I. Fennell and Kenneth B. Raper. *Mycologia* 47 (1): 68-89 (1955).

A new species of *Penicillium* from soil. P. A. Orpurt and Dorothy I. Fennell. *Mycologia* 47(2): 233-237 (1955).

#### 6. Dextran--Blood-Plasma Extender

NU-ARS

The previously reported various phases of work on the dextran program were terminated during the past year. This program led to the early availability of dextran for use by the Armed Forces, and also contributed basic information which will have value in future studies on the development of new uses of starches, sugars, hemi-celluloses, and polysaccharides derived from farm commodities. Production and detailed characterizations of many different dextrans, each having different properties, have been of great value to workers in both industrial and medical research. In the latter field, availability of these samples are contributing importantly to advances in immunochemistry. Perhaps the most outstanding discovery made was that of the controlled use of the enzyme, dextransucrase, to produce dextran of the suitable molecular weight range for use as a blood plasma substitute. A process based on this discovery was carried out in the laboratory and in a few runs on a pilot-plant scale and was demonstrated to offer economies over present practices in dextran production.

At the request of the Department of the Army and by transfer of funds from the Office of the Surgeon General, a specific segment of work will be continued during the next 2 years, under a new project to effect further improvements in the methods for dextran production by controlled enzymic synthesis.

#### Publications:

Analytical Total Acid Hydrolysis of Dextrans. R. J. Dimler, H. A. Davis, G. J. Gill, and C. E. Rist. *Analyt. Chem.* 26(7): 1142-46 (1954).

Determination of Dextran Structure of Periodate Oxidation Techniques. J. W. Sloan, B. H. Alexander, R. L. Lohmar, I. A. Wolff, and C. E. Rist, *J. Am. Chem. Soc.* 76(17): 4429-34 (1954).

Evaluation of the Periodate Oxidation Method for Structural Analysis of Dextrans. John C. Rankin and Allene Jeanes. *J. Am. Chem. Soc.* 76(17): 4435-41 (1954).

Characterization and Classification of Dextrans from Ninety-Six Strains of Bacteria. Allene Jeanes, W. C. Haynes, C. A. Wilham, J. C. Rankin, E. H. Melvin, Marjorie J. Austin, J. E. Cluskey, B. E. Fisher, H. M. Tsuchiya, and C. E. Rist. *J. Am. Chem. Soc.* 76(20): 5041-52 (1954).



Production of Clinical-Type Dextra. II. Partial Acid Hydrolysis and Fractionation of the Dextrans from L. mesenteroides NRRL B-742 and S. dextranicum NRRL B-1254. I. A. Wolff, R. L. Mellies, R. L. Lohmar, N. N. Hellman, S. P. Rogovin, P. R. Watson, J. W. Sloan, B. T. Hofreiter, B. E. Fisher, and C. E. Rist. Ind. Eng. Chem. 46(12): 2605-10 (1954).

Depolymerization of a Dextran with Sonic Vibrations or Ultraviolet Light. F. R. Watson and I. A. Wolff. J. Am. Chem. Soc. 77(1): 196 (1955).

Determination of Easily Hydrolyzable Fructose Units in Dextran Preparations. C. S. Wise, R. J. Dimler, H. A. Davis, and C. E. Rist. Analyt. Chem. 27(1): 33-36 (1955).

Kinetics of Hydrolysis of Isomaltotriose and Isomaltotriitol. R. W. Jones, R. J. Dimler, and C. E. Rist. J. Am. Chem. Soc. 77(6): 1659-63 (1955).

Preparation of Panose by the Action of NRRL B-512 Dextranucrase on a Sucrose-Maltose Mixture. Mary Killey, R. J. Dimler, and J. E. Cluskey. J. Am. Chem. Soc. 77(12): 3315-18 (1955).

Factors Affecting Molecular Weight of Enzymatically Synthesized Dextran. H. M. Tsuchiya, N. N. Hellman, H. J. Koepsell, J. Corman, C. S. Stringer, S. P. Rogovin, M. O. Bogard, G. Bryant, V. H. Feger, C. A. Eoffman, F. R. Senti, and R. W. Jackson. J. Am. Chem. Soc. 77(9): 2412-2419 (1955).

Production of Dextranucrase. Henry M. Tsuchiya and Harold J. Koepsell. U. S. Patent 2,686,147. August 10, 1954.

#### 7. New Starch Products by Biochemical Modification

NU-ARS

The desirability of converting the cereal starch component with branched molecular structures to linear molecules more suitable for some potential practical uses was discussed in last year's report. Two natural sources of enzymes for accomplishing such a conversion, broad bean and bakers' yeast, have been investigated, and the latter found to be superior. Considerable progress has been made in obtaining from the yeast an enzyme of improved stability, increased potency, and relatively high enzymic purity. The purified enzyme had little activity on linear starch molecules of the type which might be produced as end products of its action on the branched starch component. Furthermore, the yeast enzyme has been shown to split the type of molecular union known to be present at the branch points. Initial experiments confirm that the yeast enzyme can indeed partially convert branched to linear starch material. In view of this favorable progress these studies will be continued in order to establish more definitely the characteristics of the enzyme action, and the nature and properties of the products obtained.

#### Publications:

Preparation of Panose by the Action of NRRL B-513 Dextranucrase on a Sucrose-Maltose Mixture. Mary Killey, R. J. Dimler, and J. E. Cluskey. J. Am. Chem. Soc. 77, 3315(1955).

## 8. New Industrially Useful Compounds From Corn Sugar

NU-ARS

An outgrowth of fundamental studies of the reaction of dextrose, the sugar derived from cereal starches, with organic nitrogen compounds, has been the discovery of a new group of sugar derivatives having potentially useful antioxidant properties. This work was part of a basic investigation of the types of reactions which may be responsible for the nonenzymic browning of foods and feeds and which are believed to involve sugars and such organic nitrogen compounds as amines and amino acids. Conditions were developed for obtaining the new sugar derivatives, chemically classified as reductones, in favorably high yields of 20 to 30 percent by a simple one-step chemical reaction which was mentioned in last year's report. A number of different reductones, varying in properties, were obtained through the use of different nitrogenous reactants or different reaction conditions. The products have exceptionally strong chemical reducing power which make them especially valuable as antioxidants for the preservation of food quality as well as having important potentialities in other nonfood uses. A series of tests showed that the new reductones from corn sugar have properties superior to those of the antioxidants now used commercially to preserve fats and oils. For example, butter-oil, lard, soybean, and cottonseed oils have been protected from air oxidation and resultant rancidity for exceptionally long periods of time by incorporating only 0.01 percent of a corn sugar reductone into the oil. Moreover, the period of protection lasted from two to three times longer than for the presently used commercial antioxidants under the same conditions. Research will be continued during the coming year on determination of the structure of these new reductones, their toxicity to animals and their potential for use in a wide variety of commodities and processes that benefit from an antioxidant or chemical reducing agent.

## 9. New Industrial Products from Cereal Starches

NU-ARS

Oxidized starches occupy an important position in the field of starch modification to permit its wider utilization. The specific oxidizing actions of sodium metaperiodate, in contrast to the usual commercial oxidants such as hypochlorite, has been known for some time. However, the high cost of the periodate reagent has limited its use to laboratory and fundamental studies. The new process developed at the Northern Branch and mentioned in last year's report has demonstrated the feasibility of producing periodate oxidized starch at low cost by means of regenerating the reagent by electrolysis. Many of the variables of this process have now been examined in the laboratory and optimum conditions for producing the modified starch reasonably well defined. Preliminary investigations of the reactions and properties of the periodate oxystarches indicates that they may have high potential value as raw materials for the production of alcohols for use in plastics and for other purposes in which/unique polymer with properties completely different from those



present in the original starch may serve. Considerable industrial interest has developed in this product following disclosure of the research at a scientific meeting. Further studies are planned on the development of optimum conditions for the preparation of periodate oxystarch on a larger laboratory or pilot plant scale and on properties, chemical reactions, and derivatives of periodate oxystarch with emphasis on the effect of structure on physical and chemical properties as it relates to potential commercial value of the product.

Publications:

Electrochemical Production of Periodate Oxypolysaccharides, C. L. Mehltretter. U. S. Patent 2,713,553, July 19, 1955.

10. Baking Quality Evaluation of Wheat Flours WU-ARS

As a continuation of work reported last year, efforts have been made to isolate individual components of the albumin (water-soluble) proteins from wheat flours in order to evaluate their effects on the baking behavior. Their action appears more likely to be as modifiers of gluten or starch behavior rather than as structural materials in doughs or bread, but, as shown by earlier results, they may in this way contribute appreciably to the variations in baking properties found among different flours. One component of the albumins has been tentatively identified as responsible for the beta-amylase (a starch-degrading enzyme) activity of flour. A second component may be a protein containing phosphorus, a type of protein not previously recognized in the non-gluten portion of flours.

A major effort is being devoted to the assembly and construction of equipment to separate and yield albumin components in sufficient quantities for thorough study. Successful operation of such apparatus would provide the separate components for chemical characterization and for addition to doughs to determine any specific effects of baking properties.

Publications:

Differences in the Distribution of Components in Albumin Preparations from Durum and Common Wheat Flours. J. W. Pence, N. E. Weinstein, and D. K. Mecham. Cereal Chemistry 31:396 (1954).

11. Preservation of Bread by Frozen Storage WU-ARS

In continuation of work reported last year, studies have been carried out to evaluate the importance of various technological factors in the freezing of bread. The effects of different freezing and defrosting rates and different storage temperatures on bread quality have been determined by use of crumb firmness and crumbliness measurements, by taste-panel evaluations, and by moisture-distribution studies.



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Freezer temperature was found to be the most important variable with respect to the freezing rate of wrapped bread; with unwrapped bread air velocity and loaf position were factors of major importance. Freshly baked unwrapped bread can be frozen relatively rapidly and without significant loss of moisture. Defrosting rates are affected by humidity conditions as well as by air temperature, because water-vapor contributes to the heat-carrying capacity of air.

The advisability of freezing bread as soon as possible after it leaves the oven and of freezing and defrosting as rapidly as economically possible was confirmed by both physical and taste-panel results. Freezing time was found to affect crumb firmness more than defrosting time.

Storage temperatures for frozen bread are important, because firming changes continue at temperatures just below the freezing point. Maximum desirable storage temperatures were 10° F. or lower for short-term storage of a few days, and 0° F. or lower for storage extending more than a week. Bread stored four weeks at both 0° and 10° F. could not be distinguished from day-old unfrozen bread on the basis of flavor alone, but at 10° F. firmness increases were significant in about a week. Freezing did not prevent absorption of foreign odors and flavors.

The rate of firming in bread that was frozen and defrosted was found to be slightly slower than in bread that had not been frozen even though the freezing and thawing impart a certain degree of firmness before the comparisons began. For instance, bread frozen in 90 minutes at -20° F. and defrosted in 5 hours at 74° F. increased in firmness to an extent comparable to about 24 hours of storage of freshly-baked unfrozen bread at 74° F. However, 48 hours after defrosting, the frozen bread was equal in firmness to the unfrozen bread at 48 hours of age. The overall shelf-life of bread at room temperature, therefore, is not decreased by freezing.

The distribution of moisture in bread, in the usual waxed wrappers, was not changed by freezing or defrosting, nor by storage at 0° F. for seven weeks. If the storage temperature varied periodically between 0° F. and 20° F., a significant drying of the crust region occurred in seven weeks. Even very rapid defrosting by radio frequency energy had no significant effect on moisture distribution.

Frozen bread stored for more than a day or two should be wrapped tightly in a sturdy, moisture-resistant material that is flexible at low temperature. The shrinkage of bread during freezing increases the requirements to be met by wrapping materials. The composition of wrapping materials, however, affects freezing rate less than the size of the air space between the loaf and its wrapper.

Results from these studies provide operators with reference data for the selection of suitable commercial freezing equipment and procedures in order that economical application of freezing may be made with retention of high quality in bread.

Studies on the use of frozen storage for bakery products are being continued with attention to cakes, sweet rolls, etc., as carried on by means of a research contract supervised by the Western Utilization Research Branch.

Publications:

Freezing, Storage and Defrosting of Commercial Bread. J. W. Pence, Proceedings, Thirty-first Annual Meeting, American Society of Bakery Engineers (1955).

A Progress Report on Freezing, Storage, and Defrosting of Bread. J. W. Pence, T. M. Lubisich, N. N. Standridge, and D. K. Mecham. Mimeographed publication ARS-74-4, July, 1955.

Effects of Temperature and Air Velocity on Rate of Freezing of Commercial Bread. J. W. Pence, T. M. Lubisich, D. K. Mecham, and G. S. Smith. Food Technology 9: 342-346 (July, 1955).

12. Parboiled Wheat Food Products

WU-ARS

The manufacture of bulgor, a parboiled dried wheat product eaten for many years in the Near East, has been suggested to increase the market for wheat as a food both abroad and in the United States. Studies were begun to investigate methods for improving the keeping quality of bulgor and to determine suitable, practical processing conditions for conversion of wheat to bulgor.

Although bulgor has been reported to remain in good condition over long storage periods, the keeping quality of commercial lots was found to differ. Some samples became rancid in as short a time as 3 months when held at 90° F., either in sealed containers or in cotton bags. The variation in keeping quality suggests that processing conditions or choice of wheats affect storage life. Acceptable bulgor can be produced with numerous combinations of processing conditions (moisture content, temperature, cooking time), but no relationships with keeping quality have been determined thus far. The addition at arbitrarily-chosen levels of several commercially-available antioxidants now used in foods increased storage life 50 percent or more. This work will be continued to determine optimum processing conditions and antioxidant additions for maximum keeping quality, and practical ranges of processing conditions for commercial use.

13. Motor Fuel Supplements -- Alcohol-Water Injection

NU-ARS

(a) Effect on Valve Sticking and Burning in Tractors - One of the principal mechanical troubles experienced in farm-tractor operation is valve sticking and burning. Under a research contract a study--initiated in 1951 and mentioned in last year's report -- was made by the University of Illinois to determine the effect of alcohol-water injection on valve life in tractors burning regular and unleaded white gasoline and operating on Illinois farms.

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Alcohol-water injection when used with regular (leaded gasoline was found to have no effect on valve life. This is because deposits accumulate in the engine during idling or lowload operation when no injection takes place, and the small amount of alcohol-water injected during heavy-load operation is not able to dislodge or modify deposits already formed by the combustion of leaded gasoline. However, the use of alcohol-water injection allows low-octane, unleaded white gasoline to be used in tractor engines which would otherwise require regular gasoline. The rate of deposit formation and the occurrence of valve failures were greatly reduced in the tractors operated on unleaded white gasoline with alcohol-water injection.

(b) Effect on Preignition in Automotive Engines - Uncontrolled pre-ignition can cause severe damage in automotive engines. Under a research contract, Massachusetts Institute of Technology conducted tests--initiated in 1952 and briefly discussed in last year's report -- to determine the effect of alcohol-water injection on preignition in such engines.

Alcohol-water injection was found to counteract the pronounced tendency of n-heptane, representing the low-octane components of gasoline, to preignite at low speeds and high intake pressures, and did not increase the preignition tendency of any of the other classes of compounds normally present in gasoline. These results indicate that the addition of alcohol either by injection or by blending with the gasoline would not increase the tendency for preignition to occur in high-compression internal-combustion engines.

These studies on alcohol-water injection have been completed, and no further work on motor fuels is contemplated at this time.



## C. UTILIZATION OF BYPRODUCTS AND WASTES

1. Modified Cereal Residues as Soil Conditioners

NU - ARS

Commercial soil-conditioners, although quite effective in improving crop yields and in controlling erosion, have proved to be too expensive except for a limited number of specialty purposes. Studies on the possibilities of developing low-cost soil-conditioners by the chemical modification of agricultural residues were therefore undertaken.

As a result of this work, several products which compare favorably with commercial conditioners in soil-aggregating power have been obtained either from the cellulose component of wheat straw and corncobs, or from these whole residues themselves by one or more methods of chemical modification. The fact that whole residues can be modified without refinement prior to modification is particularly encouraging because of its economic significance. Moreover, the activity of several of these crude derivatives of whole residues is sufficiently high to permit their use on a broad scale, provided they can be produced cheaply enough and are found to be stable for at least a single growing season. Cost of production data are not available, since all of the products obtained to date have been prepared only on a small scale by more or less classical chemical laboratory procedures. The cost of chemicals theoretically required to produce the more active products, however, has been calculated from the degree of modification found therein and is sufficiently low in many instances to indicate that there are good possibilities of developing practical and economical processes for the production of residue-derived conditioners.

Studies are being undertaken to establish the most practical methods of producing these residue-derived conditioners and laboratory tests are being conducted to determine their effective life. (For expansion of work see proposal "Characterization and Evaluation of Cereal Residues.")

2. Improved Pulp Products from Wheat Straw

NU - ARS

Experimental work, discussed in last year's report, had demonstrated that newsprint could be manufactured, utilizing bleached mechano-chemical pulps from straw and bagasse, which would match the sheet characteristics of commonly used furnishes for newsprint. During the past year, some of this paper was used in printing 43,000 copies of one edition of the PEORIA JOURNAL. This was done on highspeed presses, and the newsprint containing either the straw or bagasse pulp (30 percent) was considered equal to regular newsprint in all aspects. It is apparent that commercial-scale operation of NU's mechano-chemical process produced pulps from wheat straw and bagasse which are quite satisfactory for replacing sulfite wood pulp in production of newsprint. Laboratory and large pilot-plant evaluations of this process have been completed; it remains, therefore, for the newsprint pulp industry to give further consideration to adoption of the process and use of wheat straw and bagasse for this purpose.

Fundamental information on the pulping of wheat straw for production of corrugating media for container board is being obtained to maintain and increase the use of straw as a practical raw material for this industry. Use of straw for this purpose has declined more than 50 percent in the last decade. (For expansion of work see proposal "Characterization and Evaluation of Cereal Residues.")

3. Survey of Surplus Straw for Industrial Processing in Dakotas

NU - ARS

Surveys of availability of surplus wheat, rye and flax straws for potential industrial processing in North Dakota and South Dakota are being conducted under research contracts with the respective agricultural experiment stations. These studies have progressed through preliminary stages and the course of future work has been discussed with station representatives. Preliminary findings indicate that certain areas in South Dakota might provide the necessary straw and other resources to support an industrial development in that State.

These surveys will be continued.

4. Evaluation of Ground Corncobs and Their Fractions in Beef Cattle Rations

NU - ARS

Studies on relative nutritive value of corncobs and their mechanically separated fractions in beef cattle rations, conducted under research contract by the Nebraska Agricultural Experiment Station, have progressed through one feeding year. These results indicate that ground corncobs and the woody ring and the chaffy fractions may be fed, at least at one level, without significant difference in weight gained. From these initial findings it may be concluded that ground corncob materials including their chaffy fractions (byproducts of processing for industrial purposes) might be fed to beef cattle with the expectation that comparable results will be realized, and without harm to the cattle. On the other hand, there is no evidence to indicate that separation of cobs into their component fractions will provide materials of superior nutritive properties.

These studies will be continued.



III. MARKETING RESEARCH (Progress Reports)A. MARKETING COSTS, MARGINS AND EFFICIENCY1. Impact of St. Lawrence Waterway on Costs of Marketing Agricultural Products

MOC-AMS

A study was initiated during the summer of 1955 to evaluate the economic impact on costs of agricultural marketing resulting from the opening of the St. Lawrence Seaway to ocean-going vessels. An attempt is being made to determine what effect the Seaway will have on net returns to producers as a result of possible shifts in the channels of distribution of agricultural products, and as a result of bringing closer to production areas water transportation for commodities which enter into farm production and living costs. Particular emphasis is being placed on grain and grain products in the first phases of the work. Background material has been collected and an article issued outlining the major problems to be faced by grain marketers and others when the Seaway opens in 1959.

Currently emphasis is on determining existing channels through which grain and grain products move between the midwest and eastern processing centers and export gateways both quantitatively and the direction of flow and a description of the handling, processing and transportation facilities and their location in the movement of grain from farm to midwestern terminals. The possible alternative routes utilizing the Seaway will be examined and transportation and handling costs of present and alternative routes compared. The cost of complete or partial deactivation of present facilities and the cost of replacement at other locations are being estimated in the event of rerouting of the movement of grain and grain products. An appraisal will be made of the effect of a possible partial deactivation of ports such as Buffalo might have on inbound grain costs to eastern feed mills.

Publication:

American Farmers and the St. Lawrence Seaway. Stanley N. Phillips, Marketing and Transportation Situation, July 1955.

2. Cost of Storing Corn and Wheat Reserves

MOC-AMS

During the year a report was completed and published on the costs of storing reserve stocks of corn in country elevators, at bin sites, and on farms. Variation in costs were associated with differences in quantity of corn stored, size and degree of utilization of storage capacity and average length of storage. Elevator storage costs decrease more rapidly with increasing volume than do bin site storage costs. Both elevator and bin site storage costs decrease as the average storage period increases. However, the reduction of storage costs by decreasing storage turnover is more pronounced in bin site storage than in elevator storage. This tends toward a cost



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advantage of storing at bin sites, given long average storage periods. Both bin site and elevator costs decrease as the degree of capacity utilization increases. The survey did not include a study of the actual costs of storing reserve stocks of corn on the farm. However, on the basis of budgeted costs, it appears reasonable to assume that, beyond the first year, farm storage costs would be higher than those at the other locations providing all cash and noncash cost items were charged to farm storage and the same turnover of grain took place in the farm storage operations.

A second manuscript is being cleared for publication covering the cost of storing reserve stocks of wheat in country elevators and on farms. Bin sites were not included as no wheat was held in this type of storage during the period of the study. Findings include the following: (1) average costs of storage decline with increases in size of elevator with the rate of decline proportionately greater for smaller sizes, (2) degree of utilization has a pronounced influence on costs and savings obtained by utilizing an elevator at full capacity overshadow economies associated with increases in size of storage unit, (3) larger size country elevators stored wheat at less cost than relatively small country elevators at any given degree of utilization with the cost advantage in larger elevators becoming progressively greater as the degree of utilization becomes less, (4) costs of storage are slightly more for flat metal storage buildings than for round metal bins in combination for the same storage volume, (5) unutilized storage space is relatively more costly in all volumes of farm storage units than in elevators, and (6) size of storage unit is directly related to storage cost.

Publication:

Costs of Storing Reserve Stocks of Corn in Country Elevators, at Bin Sites and on Farms. William C. Dachtler, Eileen M. McDonald, Richard Phillips and David N. Harrington, USDA, Marketing Research Report No. 93, June 1955.

3. Costs of Handling Wheat Received by Rail and Truck  
at Port Terminal Elevators in the Pacific Northwest

MOC-AMS  
Contract with  
**University of**  
Washington

In July 1955, a study was initiated under contract with the University of Washington to obtain cost information which would assist CCC in establishing equitable rates for wheat received at terminal elevators by truck and by rail carrier in the Pacific Northwest. Rates currently in effect under the Uniform Grain Storage Agreement were fixed about ten years ago without precise data concerning the actual costs incurred by warehousemen for performing the function. The fieldwork has been completed and a report prepared for administrative use. No publication for general release will be made of the information but the data may be incorporated with that to be obtained from the overall study of grain movement by rail, truck and water carriers.

4. Costs of Shrink and Grade Change for Stored Grain

MOC-AMS

Very little data have been available on the extent of shrink or quality deterioration as related to changes in weight and market grade when grain is stored for extended periods. Estimates of costs attributable to these factors necessarily have been only rough approximations. A study has been completed and a report is being cleared for publication in cooperation with the Iowa Agricultural Experiment Station of losses due to shrinkage and grade changes for corn stored in country elevators and at bin sites in Iowa. A similar study for wheat was initiated this year under contract with the Kansas Agricultural Experiment Station.

Costs were determined in 1955 by comparing incoming weights and grade factors with outshipments for 1948, 1949 and 1950 crop corn stored in 40 country elevators and all bin sites in 10 counties in Iowa. About 5 million bushels at country elevators and 18 million bushels at bin sites were covered. The average annual shrinkage was 0.53 percent at bin sites and 0.39 percent at country elevators. The following table summarizes these factors in terms of annual cost based on the average value of the corn using the price and discount data applied by the Chicago CSS Commodity Office in making settlements:

Storage Facility	Average annual costs		
	Due to shrinkage or loss in weight	Loss in market value due to deterioration in quality	Total
	cents per bushel	cents per bushel	cents per bushel
Country elevators <sup>1/</sup>	0.56	0.81	1.39
Bin sites	0.76	1.23	1.98

<sup>1/</sup> Average for 4 types of structures concrete, wood, steel tank, and flat steel.

Cost variation among the 4 types of elevator structures - concrete, wood, steel tank and flat steel - in most cases was greater than the variation between country elevators and bin sites. For the several elevator construction types shrinkage cost varied from 0.45 to 1.29 cents per bushel and cost of quality changes varied from 0.32 to 1.10 cents per bushel

5. Identification of Economic Factors that Affect the Price of Wheat and Wheat Products and Measurement of their Influence AEC-AMS

The manuscript of Technical Bulletin No. 1136 was sent to the printer prior to July 1, 1955. This study was designed to determine and quantitatively measure the factors that affect domestic utilization, exports, and

domestic world prices. The analyses was based on data for the years 1921-38 but appears to give satisfactory estimates for recent years. This study has already proved useful in analyzing the supply-price structure for wheat under alternative assumptions for the future. Background data, such as trends in production and utilization, are included as well as summaries of various governmental programs and studies of factors relating to price differentials within the marketing season and between markets and grades or classes.

(Study has been transferred and will be reported to the Feed and Forage Advisory Committee to cover analyses of byproduct feed and the overall feed-livestock economy--.)

Publication:

The Demand and Price Structure for Wheat. Kenneth W. Mainken, USDA Technical Bulletin No. 1136, 93 pp. ( In press.)



B. IMPROVEMENT AND EVALUATION OF PRODUCT QUALITY1. Methods of Controlling Stored-Grain Insects.

BS-AMS

These studies to improve and streamline stored-grain insect control procedures are carried on at Manhattan, Kansas, (wheat and corn), Houston, Texas, (grain sorghum), Mesa, Arizona, and Fresno, California, (Khapra beetle), and Tifton, Georgia, (corn, lupine seed). In the North Atlantic area they are carried on by the New Jersey Agricultural Experiment Station under a contract negotiated in June 1955. The studies on insect-resistant packaging, and the chemical analysis for residues, are carried on at Savannah, Georgia. The overall program has many facets, including research to implement the program for better grain sanitation sponsored by USDA and HEW, treatments for commodities and buildings infested with the khapra beetle, and development of improved procedures for specific use at CCC bin sites. The progress will be reported under appropriate sub-headings.

(a) Khapra beetle. The khapra beetle program was 4-pronged this past year. At Mesa, all research was directed towards improving the treatment schedules for commodities regulated by the Federal Khapra Beetle Quarantine, by developing a graduated series of fumigant dosage rates for temperatures between 50° and 100° F. to equalize the effect on seed stocks regardless of the existing temperature level. Alternate methods of fumigating seeds were also under intensive study. These phases were done in participation with Western Regional Project WM-16.

Cooperative studies were also done with the California Bureau of Entomology out of the Fresno station, to develop procedures whereby entire structures could be covered with tarpaulins and fumigated to eliminate the khapra beetle and release the structure from the quarantine. As of October 1, 36,000,000 cubic feet of storage space comprising 96 storage sites, had been so fumigated and released from quarantine, based on the procedures so developed. The largest structure was 4,000,000 cubic feet, and took 17 acres of tarpaulin to cover it, at a cost of over \$37,500.00 just to cover the building.

A 3-year contract was negotiated with the Arizona Agricultural Experiment Station to conduct studies on the behavior of the khapra beetle under natural environmental conditions. Work was begun on this study July 1, 1955

Research results from all sources--California Bureau of Entomology, State Experiment Stations in Arizona and California, State Seed Laboratories, and the Federal Research stations--were reviewed and treatment procedures to be used under the Khapra Beetle Quarantine formulated and recommended to a coordination group comprised of the Federal and State Officials administering the quarantine.

(b) Protective dusts and sprays for grain. Performance tests have been completed on several candidate formulations, to evaluate the degree of protection provided for one, two, and three seasons at different rates of application. Samples have been analyzed at intervals to determine the insecticidal residues remaining, and bioassay tests, wherein insects were

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confined for one and three weeks on samples from treated bins made to determine the degree of toxicity present at those intervals. A picture of the persistence or deterioration of each formulation has thus been developed. Dusts of ryania, lindane, and methoxychlor protected grain from infestation in excellent fashion up to 2 or 3 years after application. Pyrethrum dusts and sprays protected grain through 2 seasons when applied at rates giving a deposit of  $1\frac{1}{2}$  ppm or more of pyrethrins. Malathion tests are now under way.

A large scale milling test was performed in cooperation with the Sanitation Committee, Association of Operative Millers and the manufacturers of the test formulations, to demonstrate the fate of insecticidal residues in the milling process. The cleaning process at milling removed about one-fourth of the residues of Malathion and methoxychlor, but little or none of the residue of lindane. There was very little residue in the patent flour, but increasingly greater amounts in the first and second clear flour, shorts and bran. No samples of pyrethrum or ryania treated grain were milled since no analytical method is available for low levels of residue.

As reported last year, the baking process destroyed about half of the residue of methoxychlor but practically none of the lindane.

The performance, milling and baking data were reviewed with Food and Drug Administration officials concerned with establishing tolerances under the Miller Bill, and some questions remain to be answered. Further milling tests were needed to better establish the range of residues in flour. At this point the possibilities of methoxychlor for this purpose look promising from the level of residues resulting in the flour, but lindane and ryania do not look as good. Lindane residues remaining in the flour are too high, and there is no analytical method for ryania at these levels. Pyrethrum has a clean bill of health and is already on the market and in wide use as a protective spray. It is rather expensive, however, costing in the neighborhood of 2 cents per bushel.

(c) Recirculation of fumigants. Studies on the recirculation method of applying fumigants using air flow rates in the range produced by mechanical aeration systems, have progressed rapidly. Three tests were made with wheat in the same elevator tank in which shelled corn was fumigated, as reported last year. The more compact nature of the wheat reduced the air flow rates by  $1/3$  to  $1/2$ , but the gas distribution was still satisfactory. Additional tests were made in large and small flat storages, metal tanks, and elevator tanks. It was demonstrated that HCN, and most of the common liquid grain fumigants such as the 80-20 and 75-25 formulae, could be distributed satisfactorily by using existing aeration systems, and that the dosage rate on the liquid types could be reduced by about one-half.

Fumigant manufacturers have prepared brochures giving complete directions relative to applying fumigants to bulk grain by recirculation, and have included much detailed information on blowers, flow rates, etc. These



brochures were reviewed by Department entomologists and engineers before printing, to assure accuracy. A number of commercial elevators and warehouses are considering installation of dual aeration and recirculation systems.

(d) Consolidation of research for CCC. Research on the improvement of procedures used at CCC-bin sites, which has been under way for several years, was all brought together within the Marketing Research Division in the recent reorganization. The field studies have been conducted at regular bin sites in several states where appropriate conditions could be found. Recently an experimental bin site was set up at Watseka, Illinois, which will be operated by the AMS committee on CCC-research, and an effort will be made to consolidate all of the research at that point. The engineering and cost studies are already under way at the new site, and the entomological work will be shifted to there as fast as current field tests are completed.

(e) Development of insect-resistant packaging. Laboratory techniques have been developed that give reproducible results, to evaluate the toxicity and the repellency of candidate insecticides and repellents when applied to kraft paper. This makes it possible to rapidly screen a larger number of candidate materials. During the past year 239 candidate repellents have been screened. These were supplied by the Entomology Research Branch, ARS, and had either shown repellency to other insects, or were closely related compounds to those that had.

A new and sensitive color reaction for pyrethrins has been developed by the Chemical Unit, for the determination of residues of kraft paper. This insecticide has both toxic and repellent characteristics and is the only one approved to date to make packages insect-resistant, and this new technique will advance research considerably.

As a result of a publication summarizing the research results to date, and reviewing the status of insect-resistant packing research, several offers of extensive cooperation have been received from industry firms.

(f) Development of procedures for insect control in mills and warehouses. A study is under way in cooperation with the Sanitation Committee, Association of Operative Millers, at three flour mills in Springfield, Illinois, to compare the effectiveness and efficiency of three types of spot fumigants used to treat milling machinery at monthly intervals.

Extensive studies are being made to develop procedures that can be safely used in warehouses. The use of aerosols to subdue populations of the Indian-meal moth and related species, and other stored-product insects, is under test, and the amount of residue accruing because of settle-out on the exposed surfaces, is being determined. The effect of this residue on the amount of time elapse permissible between applications, and the migration of the insecticide into the product are also under study. Recommendations for a clean-up and aerosol program in peanut warehouses was published in AMS-58. These instructions are applicable in many ways to warehouses storing dry food products.



(g) Establishment of tolerances under the Miller Bill. All recommendations by the Department for control procedures to use against stored-product insects have been reviewed to determine (a) if residues resulting from their use as recommended will fall within the proposed tolerances, and (b) if all uses on all commodities are included in petition for tolerances. In the case of grain fumigants it has been necessary to do extensive research in cooperation with manufacturers, and the Food and Drug Administration, to determine if residues occur in grain as a result of fumigation, and if so, of what level and character is the residue. These studies were scheduled to be completed so that the tolerance, or exemption from tolerance, could be established for each fumigant by the first of the new year.

All residue data available in the Department were turned over to manufacturers of pesticides to use in support of their petitions for tolerances. Also any use recommended by the Department which was unknown to a manufacturer was called to his attention for inclusion in his petition, and supporting data provided if not otherwise available.

Only raw agricultural products are covered by the Miller Bill, and residues on processed, milled, or manufactured food products must be considered under Section 406 of the Food, Drug and Cosmetic Act, which deals with chemical additives to food. At the present time this section requires formal hearings to set tolerances. Extensive discussions have been held with Food and Drug officials to consider the approach to the use of insecticides on or around processed foods, and on insect-resistant packages. Research plans were reviewed with them and a selection made as to necessary studies to use as guide posts in further consideration of this problem.

Plans. Due to the urgency of problems raised by the khapra beetle, the grain sanitation program, the increased amounts of surplus grain, particularly grain sorghum, in storage, and the demand of the public for insect-free dry food products, this work will be expanded as rapidly as possible. The demands for research results are so varied and extensive, that the research staff should be multiplied by three or four times to meet the need. It is proposed that the expansion take place in all three fields of study related to grain and grain products: first, to improve methods of preventing infestation in the grain; second, to improve control measures for use in warehouses, mills, and retail outlet storages, so that insecticides can be used most effectively without contamination of the food products; and third, the development of insect-resistant packages to help prevent infestation of packaged products while in marketing channels. (See Marketing Proposals).

#### Publications:

1. A Laboratory Apparatus for Determining Repellency of Pyrethrum When Applied to Grain. H. Laudani and G. R. Swank, Journal of Economic Entomology 47(6):1104-1107, September 1954.
2. Khapra Beetle--Newcomer Pest. R. T. Cotton, Agricultural Situation 38(12):3, December 1954.

3. How to Look for the Khapra Beetle. USDA Program Aid 261, January 1955.
4. Grain Fumigation. G. L. Phillips, Agricultural Chemicals X(1):55-56, 117-121; X(2):41-43, 133, 135. January-February 1955.
5. What are We Doing About the Khapra Beetle? R. T. Cotton, Proceedings North Central Branch Entomological Society of America. March 24-25, 1955.
6. The Growing Demand for Increased Research on Stored-Product Insects. Randall Latta, Proceedings North Central Branch Entomological Society of America, March 24-25, 1955.
7. Stored Grain Fumigants. H. H. Walkden, Proceedings North Central Branch Entomological Society of America. March 24-25, 1955.
8. Out to Get the Khapra. L. S. Henderson, Agricultural Situation 39(4):10-11, April 1955.
9. The Khapra Beetle. R. T. Cotton, Modern Sanitation 7(5):26-28, 47-48, May 1955.
10. The Khapra Beetle--Current Status. L. S. Henderson, Proceedings 41st Midyear Meeting, Chemical Specialties Manufacturers Association. May 16-17, 1955.
11. Insect Prevention and Control in Food Plants. L. S. Henderson, Pest Control 23(5):18, 20-22; 23(6):18, 20-22. May and June 1955.
12. An Insect Preventive Program for Peanut Warehouses. AMS-58, June 1955.
13. The Status of Federal Research on the Development of Insect-Resistant Packages. H. Laudani and D. F. Davis, TAPPI 38(6):322-326, June 1955.
14. A Laboratory Method of Evaluating the Repellency of Treated Paper to Stored-Product Insects. H. Laudani, D. F. Davis, and G. R. Swank, TAPPI 38(6):336-341. June 1955.
15. Treatments Approved for Regulated Commodities and for Eradication from Premises under the Khapra Beetle Quarantine. Randall Latta, Proceedings 36th Annual Conference Western Plant Board. June 16-18, 1955.
16. Protecting Stored Seed from Insect Attack. AMS-64, July 1955.
17. A Study of the Role of Vacuum Cleaning in the Control of Insects in Flour Mills. Albert C. Apt, Milling Production 20(8):5-7, August 1955.
18. The Khapra Beetle--A Situation Report. ARS 22-17, August 1955.
19. Stored Grain Pests. USDA Farmers' Bulletin No. 1260 (revised) August 1955.

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2. Botanical and Plant Pathological Problems Involved in Corn Storages BS-AMS

A contract was negotiated with Iowa State College of Agriculture and Mechanic Arts effective July 1, 1955 to conduct these studies. At report time, work had begun on assembly of appropriate equipment and assignment of qualified personnel.

3. Attraction of Stored-Products Insects with Electromagnetic Radiation BS-AMS

Work has been initiated on the attraction of stored-products insects with electromagnetic radiation in cooperation with AERB, ARS, and the Texas Experiment Station. Monochromatic light sources and light-measuring instrumentation has been developed and assembled to test the spectral response of insects to visible and ultra-violet light. A radiation tunnel built under another project has been tested for use with stored-products insects. These tests show the tunnel to be unsatisfactory and modifications are now being made. Upon completion of these modifications, tests will begin to determine the response of insects as wavelength, size, and intensity of light source is varied.

4. Simple Fat Acidity Test BS-AMS

In the past it has been shown that fat acidity is a useful index of the soundness of grain and the test has been simplified so that it may be practical for routine use. During the year the simplified test was applied and it appears to be satisfactory. The advantage of this procedure over the official method is that a single operator can perform 8 to 10 tests per hour with simpler and less expensive equipment.

Further study has been made concerning the relationship of moisture content to fat acidity values. It has been noted that the value varies with the moisture content of the sample at the time of extraction. Tests have shown that the oil extracted at higher moisture levels contains a greater percentage of nitrogen and phosphorus and also shows a higher acid value. This indicates that phosphelipids are more easily extracted at the higher moisture levels and that some hydrolysis of the fats may also occur. A combination of these two factors could cause fat acidity values to fluctuate with the moisture content of the sample. Data are being collected to determine a correction factor or a standard moisture level for fat acidity determinations.

A survey of the fat acidity values for varying degrees of soundness in different grains was completed. Pending the outcome of the study on moisture in relation to fat acidity values, the data from the survey has not been fully analyzed.

It is planned to establish the correction factor for moisture content to be applied to fat acidity values of wheat and to study this factor for the other grains. The applicability of the simplified fat acidity test to



all the grains will be explored. When these details have been accomplished, a field trial of the test will be inaugurated and collaborative studies conducted.

#### 5. Measuring Bread-Baking Quality of Wheat

BS-AMS

Continued collaborative studies of the sedimentation test have shown increasingly good agreement among laboratories. No basic changes have been made in the method. Slight changes in the description of the technique of performing the test have been made in an effort to improve interlaboratory agreement. Chairmanship of the American Association of Cereal Chemists Sedimentation Test for Wheat and Flour Quality Committee is maintained by a worker in this project. This work aids in the development of the test.

About 700 samples of wheat and 800 samples of experimentally milled flour were tested. In addition, 300 or more tests were made in the study of the procedure.

Six more field offices of the Grain Division were equipped and personnel trained to make the test. In all there are now eight field offices which have been furnished equipment to make the test and which have personnel trained for that purpose. Reports from these offices show very good interlaboratory agreement. A number of commercial laboratories have evinced interest in this test and they have already instituted this test or indicated their intention of doing so.

The biuret test is being applied to a fundamental study of the mechanism of the chemical and physical reactions of the sedimentation test.

Samples of the four classes of wheat of the 1955 crop will be tested for sedimentation values, protein content, baking results, and related data. As regards the sedimentation test itself, investigations will be made of the effects of moisture content of the wheat, particle size distribution in the prepared flour sample, and the age of the sample on the sedimentation value. Direction of the collaborative work will be continued for the coming year with a committee that has nearly doubled in membership.

#### Publication:

Sedimentation Test (mimeographed instructions for performing the sedimentation test) 4 pages, issued November 1954, revised February 1955.

#### 6. Consumer Preferences for White Pan Breads

MD-AMS

Preference tests of bakers' white pan bread formulas that vary in specific volume, percentage of lard, percentage of sucrose, and percentage of nonfat milk solids have been completed. In carrying out these tests, two experiments were conducted, one in the spring of 1954

and the other a year later. The first experiment was conducted to determine preferences for those formulas that were selected on the basis of discrimination tests. The second experiment was conducted to measure the effect on preference of varying levels of nonfat milk solids and lard, and to determine the preference position of a formula representing the "commercial standard" in relation to the test formulas.

Breads used in the preference tests were baked by the American Institute of Baking in Chicago, Illinois. The preference tests were conducted in two representative samples of households in Rockford, Illinois.

The results of these tests indicate that preferences for bakers' white pan bread are affected by specific volume and varying levels of ingredients. In general the formulas which received the highest preference ratings were those of high specific volume (10 cubic inches per ounce as opposed to 7 cubic inches per ounce) and a high level of ingredients (lard, sucrose, and nonfat milk solids). More specifically the results indicate the following effects of varying the levels of specific volume and ingredients:

- (1) Increasing specific volume from 7 to 10 cubic inches per ounce significantly increased preference.
- (2) Increasing the sucrose level from 2 to 7 percent significantly increased preference.
- (3) Increasing the nonfat milk solids level from 0 to 4 percent significantly increased preference.
- (4) Increasing the nonfat milk solids level from 4 to 8 did not significantly increase preference.
- (5) Increasing the lard level from 3 to 5 percent did not significantly increase preference.

The "commercial standard" formula was not rated significantly different from the most preferred test formulas.

A report of this research to date should be available early in 1956.

7. Feeding Value of Artificially and Naturally  
Dried Corn after Storage

BS-AMS and  
APH, ARS

Further tests on the nutritive value of government surplus stored corn and artificially dried stored corn were made by rat feeding tests. Corn harvested in 1948 naturally dried or dried in mechanical driers up to 173° F. was found to be equal to current crop corn in energy and supplementary protein value. This was shown by high feed efficiency values and optimum growth of animals fed practical diets containing 80 percent corn. Current work and future plans are to test available stored corn samples further for possible changes in energy and protein nutritive value and deterioration in vitamin potency especially vitamins A and E. Of the vitamins provided by corn, these probably make the

most important contribution to animal diets and are the most susceptible to oxidation.

Publication:

Feeding Value of Stored Corn. C. W. Cabell and N. R. Ellis, to appear in Jour. Animal Science, November, 1955.



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C. IMPROVEMENTS IN MARKET ORGANIZATION AND FACILITIES1. Methods for Determining Moisture Content in Grains,  
Seeds and Other Farm Crops BS-AMS

Work was done on the Karl Fischer method for the determination of moisture content of grain. The following aspects of the method were pursued:

1. Selection of the best solvent for extracting all of the water from the grain.
2. Ratio of solvent to grain for optimum extraction.
3. Determination of the nature and quantity of interfering substances in the grain which carry over to the solvent.
4. Determination of interferences in the blank (no sample).

The results obtained by the Karl Fischer method were compared with those obtained by the official oven method and in most instances the agreement was very good. In those cases where there was variance it was demonstrated that the oven methods were in error. The results of this work will be offered for publication in a technical journal.

Work was continued on the measurement of weight changes in grain when samples were equilibrated at various relative humidity conditions. This phase of the work is not yet completed.

It is planned to continue the work on the Karl Fischer method as applied to rice, beans, dry peas, hay, and agricultural and vegetable seeds. Work will also be done on the feasibility of measuring the electrical properties of a solvent extract of water from grain as a basic method. In the applied field promising electrical moisture meters will be tested for their suitability and accuracy in determining moisture content of grain.

2. Development of New and Improved Methods for Sampling  
Grain BS-AMS

Inasmuch as no satisfactory solution has been found for properly sampling grain in boxcars under present load conditions, the testing of automatic samplers to determine their possibilities, as an alternate sampling method, was continued. In order to overcome the problems which were encountered in previous years in testing automatic samplers in a wide variety of locations, most of the work this year was done at Omaha. This resulted in considerable progress being made, as it was possible, for the first time, to get several different kinds of samplers installed under the same working conditions where comparisons could be made with samples obtained by the probe and pelican methods. Comparisons obtained under these conditions showed

the fallacy of comparing results of automatic samplers solely with the results of samples obtained by the probe method.

The three types of samplers under test were the Woodside belt sampler, the Johnson belt sampler, and the Johnson spout sampler. Additional information was collected on the Woodside belt sampler which will be extremely useful in dealing with present and future installations. It was necessary to make many changes and improvements in the Johnson type samplers. The Johnson type sampler is more versatile than the Woodside, as one version can be used on a belt and another on a spout. Both models show satisfactory results on wheat but they will have to be tested on corn, soybeans, and flaxseed before they can be adopted for use in official inspection.

A large number of Woodside samplers were installed in terminal elevators for use in sampling grain as it was being loaded or unloaded from barges and boats. In addition, several terminal elevators are employing Woodside samplers for truck sampling.

The work under this project was discontinued June 30, 1955, because it did not appear that sufficient progress was being made to justify its continuance.

### 3. Marketing High Protein Wheat

MOC-AMS  
Contract with  
the Research  
Foundation  
Montana State  
College

The purpose of this study is to describe the various marketing channels and the methods followed in handling high protein wheat, to assemble data which will assist producers in visualizing the market supply and demand structure, to improve efficiency in marketing high protein wheat and thereby improve the farmers share of the premiums paid. This contract with the Research Foundation at Montana State College terminates in May, 1956. All fieldwork among producers, elevators, dealers and millers has been completed and two separate preliminary reports have been prepared and submitted by the contractor. These preliminary reports cover an analysis of price and premium data, and the factors influencing the supply and demand for high protein wheat, as well as the marketing and handling methods followed by producers, elevators, dealers and millers.

The contractor is now in the process of final analysis and preparation of a final report which is to be published by the contracting institution.

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4. Grain Marketing in the North Central RegionMOC-AMS  
FSC and North  
Central Regional  
Grain Marketing  
Committee

A manuscript entitled "North Central States Grain Warehousing Regulation" was prepared during the year and now is being printed by the Kansas Agricultural Experiment Station for release as a regional publication. This report embodies the results of a survey and analysis of the State laws, regulations and their administration together with a comparison with the U. S. Warehouse Act and CCC regulations on grain storage. Considerable variation was found among States in the North Central region and the report serves to point out deficiencies in the provisions made for the protection of the holders of grain warehouse receipts.

Fieldwork was completed on the inventory of terminal storage facilities and is practically completed for country elevators. All terminal, subterminal and processor storage capacity in the region has been categorized and information collected on size, type of business, extent of grain handled, availability of transportation facilities and origins and destinations of grain handled. Similar data have been collected for a 15 percent sample of the country elevators in each crop reporting district in the region. The information obtained from these surveys is being tabulated and will be combined with data from published sources in an overall report on the extent and characteristics of grain storage in the Corn Belt.

Emphasis now is being directed toward a study of grain prices and buying practices in the North Central Region.

Publication:

North Central States Grain Warehousing Regulation. Stanley W. Phillips, North Central Regional Bulletin, In Press October 1955.

5. Marketing Practices and Channels Used by Industrial Feeding Facilities in Purchasing FoodsMD AND  
MOC-AMS

Arising with the changes brought about by World War II, inplant food services grew and expanded until today they are ranked along with hotels and hospitals as a market outlet for foods. Because only scattered data are available concerning their marketing practices and use of food, a study of the feeding facilities provided to employees by manufacturing plants has been undertaken under contract with a private marketing research organization. In addition to a general picture of management attitudes and plans related to inplant feeding, the study will procure comprehensive information about the foods used for one month: the beginning inventory, purchases made, and ending inventory, including the quantity, quality, and cost of the food used; sources of supply and management evaluation of these sources; the extent to which prefabricated or commercially prepared foods are used. The data gathered will



be presented in several commodity reports, one of which will be devoted to flour, cereals, and bakery products used in this particular market. Fieldwork will be carried on during the winter of 1956 and preliminary reports are planned for fall 1956.

6. Economic Considerations for New Investments in Grain Elevators - Their Equipment and Size for Various Volume Specifications

FCS

The Kansas phase of this study was completed during the year. Results have general application for country elevators in those parts of the Hard Winter Wheat Belt where wheat constitutes most of the grain volume marketed.

The Kansas study shows new modern concrete elevators of 200,000 bushel capacity or more have substantially lower annual per bushel costs of merchandising and storing grain than new smaller elevators, when either size is handling or storing near its maximum practical volume. Of course, maximum practical volume in the Hard Winter Wheat Belt is larger for the elevators with larger capacity for storage and for handling of merchandising equipment.

A second phase of this study is being conducted in cooperation with the University of Illinois. It deals with the same problem as it exists among country elevators in a major Corn Belt state. Limited time of available personnel for this project has resulted in slowing up the work accomplished. Some further analysis of data was completed, indicating volume in relation to elevator and equipment size or capacity may be substantially higher than results show for the Wheat Belt.

Plans are to complete the Illinois phase of the study and start the subterminal or terminal elevator phase.

Publications:

New Local Elevators - Cost Volume Relations in the Hard Winter Wheat Belt, FCS Service Report 12, May 1955, 112 pages.

New Country Elevators - Influence of Size and Volume on Operating Costs, FCS Circular 10, June 1955, 29 pages.

7. Economic Considerations in Grain Conditioning Practices on Farms and at Country and Terminal Elevators

FCS

The FCS publication, Artificial Corn Drying by Selected Elevators in Indiana, was reported last year as a cooperative study by FCS with Purdue University. This year Purdue has prepared an Experiment Station Bulletin giving results on farm drying operations in Indiana with FCS as the cooperating agency. This publication is at the printers and will be distributed about the first of the calendar year 1956.

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The current phase of this study deals with practices used by elevators in Kansas to condition and maintain quality in storage of new crop wheat. The study is being conducted in cooperation with Kansas State College.

Plans for next year are to complete the current study phase and begin a similar study of the problem in subterminal and terminal elevators.

8. Storage Levels

MOC-AMS  
Contract with  
Chicago University

The principal objective of this study, namely, to provide the Department with a more comprehensive treatment of some of the points contained in the Departmental Report to the Senate Agricultural Committee, has been served as reported last year. The material submitted by the contractor has been summarized and a manuscript is being prepared for general release.

9. Futures Trading

MOC-AMS  
Contract with Brookings  
Institution

Additional revision of the manuscript draft reported last year has been necessary and it now is expected that a report will be completed and published by the Brookings Institution in the near future.

10. Mechanical Aeration of Grain in Commercial Storages

TF-AMS

This research was undertaken to explore the feasibility of using mechanical aeration systems to move atmospheric or conditioned air at rates of 1/60 to 1/2 cfm per bushel through stored grain in commercial storages to cool or equalize grain temperatures, in order to minimize, and possibly eliminate, the need for turning stored grain. Although much more work remains to be done in developing mechanical aeration systems for commercial grain storages, the results of one year's work show that substantial savings could be made by substituting aeration for turning grain from one bin to another in order to cool and equalize the temperature of the stored product. Moreover, tests show that none of the grain used in aeration experiments deteriorated in quality or had objectionable storage odors. Preliminary data, for the types of grain and kinds of storage structures used in experiments, indicate that storage operators could save an average of 4/10 cent per bushel per "season" by aerating rather than turning grain. Assuming that roughly 50 percent, or roughly 250 million bushels, of the grain in commercial storages on September 17, 1955, will remain in storage at least one full season and that this grain could be aerated rather than turned, the potential saving would amount to \$1,000,000.



Other significant findings and trends resulting from these initial aeration tests are; airflow rates of from 1/50 to 1/10 cfm per bushel provided effective cooling in storages of up to 90,000 bushels capacity with grain depths ranging up to 140 feet; where individual aeration units were used on each bin, the experimental systems were installed at an estimated cost of from roughly one cent per bushel for deep bin storages of 50,000- to 60,000-bushel capacity, to roughly 5 cents per bushel for small storages of 3,200-bushel capacity. It should be possible to prorate these equipment and installation costs over a 10-year or longer period. Annual fixed costs then would amount to from 1/10 to 1/2 cent per bushel; data obtained from aeration tests to date indicate that power costs range from 1/10 to 1/2 cent per bushel. Therefore, total annual ownership and operating costs (exclusive of labor required with manual controls to start and stop the blowers) would range from 1/5 to 1.0 cent per bushel.

Industry cooperation and relationship have been excellent. No request for equipment from manufacturers or storage operators has been refused. Contributions by storage operators have been extensive, including experimental equipment and thousands of bushels of grain for use in the studies. Research will be continued through the field offices at Ames, Iowa; Athens, Ga.; College Station, Tex.; Lafayette, Ind.; and Manhattan, Kans.; to determine the economic effectiveness and efficiency of mechanical aeration in reference to size and type of system, number of bins per aeration unit, kind (moisture content and temperature) of grain, operating schedules, airflow rates, airflow direction, and use of aeration systems for applying fumigants to stored grain.

#### 11. Conditioning, Handling and Storing Grain

TF-AMS

The estimated capacity of commercial grain storage facilities in the United States exceeds 2 billion bushels, which is sufficient capacity to store from 30 to 35 percent of the total production of the 8 major grains grown in the United States. A considerable portion of the other 65 to 70 percent produced also moves through these commercial facilities and considerable volumes are handled more than once. Handling operations at commercial storages and warehouses involve moving the commodities into, within, and out of the facilities. The handling equipment for each group of operations must be related in capacity to the equipment for other operations and to the storage capacity if the greatest efficiency is to be obtained. Labor and other costs are such that over one-half of the total costs of handling and storage are operating or out-of-pocket costs. This situation has stimulated interest in labor-saving devices and a trend to high capacity handling equipment of simple design.

The initiation of handling studies is under way on wheat in Kansas and grain sorghums in Texas. Commercial upright- and flat-type storages representing significant variables with respect to facility design and size will be selected for the studies. Studies will include survey of existing methods and equipment, timing of segments of specific handling operations, preparation of flow charts and diagrams, and basic information on equipment and equipment installation. Methods analysis will be



used in improving existing work methods and equipment and developing plans and working drawings for new handling equipment. These studies have not progressed to the extent that any results are available. This work will be continued with initial studies to evaluate the present methods of turning grain as a comparison with costs of mechanical aeration.

12. Grain Marketing Facilities in the Coastal Plains  
Area of North Carolina

TF-AMS

This study, carried on in cooperation with the North Carolina Department of Agriculture, has been completed and a report issued. In the report it is suggested that there are six locations away from the most concentrated areas of corn production where low-cost grain assembly and shipping elevators would have a reasonable chance of being economically feasible. In the most concentrated areas of production the number of elevator units in their existing locations appear to be sufficient to render good service to farmers. About half of these elevators have been modernized in recent years and about half needed modernization in 1954 to allow them to do a low-cost grain handling job. It is probable that the prevention of damage to corn caused by insects and high moisture content can be accomplished at lowest cost on the farms where a high percentage of such damage occurs. Very little damage occurs in off-farm facilities because such facilities are used primarily to move corn further on in marketing channels, with very little corn being stored for a long period of time in off-farm facilities. It is estimated that the prevention of damage to the corn crop on farms would require on-farm facilities costing around 18 million dollars, but each year damage of nearly 5 million dollars could be prevented by the intelligent use of such facilities.

13. Grain Marketing Facilities and Practices  
in South Carolina

TF-AMS

This study, carried on in cooperation with the South Carolina Extension Service, has been completed and a report is in process of publication. In the study, it was found that no significant areas are materially handicapped by not having grain marketing facilities within a reasonable hauling distance. However, nearly two-thirds of the existing facilities at grain buying points were considered poor to worthless in doing an efficient grain receiving and handling job. The major damage to grains caused by insects and high moisture content occurs on farms. Most of the feed grains were fed on the farms where grown, although the off-farm commercial movement of oats has increased greatly in recent years. The prevalence of inefficient off-farm facilities in many areas makes wide handling margins necessary, and the heavy damages caused primarily by insects in inadequate farm storage result in heavy discounts, or decreases the nutritive value of the grain when fed to livestock on the farm. About 23 elevators were reasonably efficient in receiving and handling grains although several of these operated in connection with grain processing business needed to become unlimited grain buyers in order to render the most economical service to farmers within their trade area. The modernization of off-farm facilities and the use of food on-farm storage facilities would decrease handling margins and minimize grain damage. The cost of building or acquiring good storage facilities on farms would be returned to farmers in damage prevention within 3 or 4 years.

14. Grain Marketing Facilities in Kentucky

TF-AMS

In late fall of 1954 a study of facilities for the marketing of grain was begun in the State of Kentucky in cooperation with the Kentucky State Department of Agriculture. Data has been collected and are being analyzed.

Plans:

To publish the report now in preparation covering grain marketing facilities in South Carolina and complete the work begun in Kentucky.

Publication:

"Grain Marketing Facilities in the Coastal Plains Area of North Carolina", Marketing Research Report No. 100, Perry S. Richey, Thew D. Johnson, J.B. Cotner, et al, AMS-USDA--N. C. Dept. of Agriculture, August 1955.

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D. COLLECTION, ANALYSIS AND DISSEMINATION OF  
MARKET DATA

1. Family Food Consumption Survey, Spring 1955

MD-AMS

Fieldwork has been completed on the survey of family food consumption which will show quantities of food consumed by families during a one-week period in the spring of 1955, based on a representative nation-wide sample. Information will be available on the basis of geographic regions and family income groups for farm, rural nonfarm and urban families. In addition to food consumption data, information will be included about home baking practices, home produced food, freezing facilities, and home canning and freezing of food in 1954. This survey also will provide information on current food consumption patterns which will permit making estimates of the nutritive content of diets and will show the extent to which food consumption patterns meet the recommendations of nutritionists. Information for the market analysis will be available in relating consumer behavior to economic and other factors that determine consumption patterns, in delineating areas of substandard consumption, and in evaluating programs designed to stimulate consumption. Tabulation of the data is under way and it is expected that basic consumption information from the survey will be published in the fall of 1956. Special reports and analyses will be made later.



#### IV. MARKETING SERVICE AND EDUCATIONAL WORK

##### A. SERVICE WORK OF USDA

##### 1. Foreign Outlets for Grain and Grain Products

FAS

The program to expand foreign outlets for U. S. grain and grain products is being intensified. Marketing specialists are continuing to maintain close personal contacts with government officials and trade groups in foreign areas. The program also involves analyses and studies based on reports of the agricultural attaches covering all phases of competition abroad. This includes continuing scheduled reports on acreage, yield, production, imports and exports as well as special studies of prices and price policies, trade barriers, bilateral agreements and all other factors affecting grain movement.

(a) Maintaining and expanding existing markets. The Grain Division of FAS is working with Government and industry representatives, and others, in a program aimed at expanding existing markets as well as developing new outlets throughout the world. This involves analyses of our competitive position in foreign markets and studies of trade barriers, exchange difficulties, bilateral trade agreements, and other factors which in any way influence the competitive status of U. S. grains in world markets. It likewise includes an analyses of production levels and trends and other factors bearing upon the outlook for U. S. trade in specific areas. Grain marketing specialists are making trips to and studying the factors affecting U. S. grain exports to Europe, Asia, Latin American and West Africa. These specialists work closely with the agricultural attaches and with private grain and flour exporters. It has been found necessary for FAS to have a few specialists travelling in other countries to obtain first hand knowledge of local conditions and policies in order for us to render effective service to the private trade.

(b) Special projects for market development. One important development in this program has been the finalizing of several projects aimed at increasing the consumption of grain and grain products through market development work. Local currencies generated from sales under Public Law 480 are available for this type of promotional activity which will be done in cooperation with the Oregon Wheat Growers League, Millers' National Federation, and perhaps others. This is a type of activity which has long been considered desirable in connection with further developing export markets, particularly those in the Far East.

(c) Study of wheat quality. A project is continuing to study types, grades, and milling and baking qualities of wheat moving to European markets from the United States and competing exporting countries. We collected 133 samples of such wheat from last year's crop and have made quality evaluations in cooperation with AMS, ARS and the Kansas

State College. The results will soon be published. In addition, 300 samples from the 1955 crop movement are being collected and will be tested in laboratories. Dr. John Shellenberger of Kansas State College has served as Consultant to FAS in the formulation of procedures for collecting these samples and for subsequent quality evaluations. This work is considered very important because it will shed some light upon the comparison, quality-wise, of U. S. wheat exported to Europe compared with that from competitors.

(d) The development of new outlets in the Far East. This is an area in which the Grain Research Advisory Committee has expressed considerable interest for several years. The consumption level is low in the Far East and even a small increase in the per capita rate would greatly increase the requirements because of the large population. The Far Eastern grain marketing specialist was a member of the Presidential Trade Mission to the Far East in 1954. Later he was accompanied by representatives of the trade on several trips to this area and he departed on October 6 for another trip which will terminate about December 2. He has contributed to developing specific educational and market development projects. He also has obtained and disseminated to the trade information on foreign governmental policies and programs, and other factors affecting trade in such areas, particularly as such factors relate to the actual and potential competitive position of the U. S. in the Far Eastern market.

(e) The wider and more effective use of basic data available from Foreign Service and other reports. The program for collecting, analyzing, and disseminating information from abroad on grain production, trade, prices, consumption, utilization, governmental programs and policies and related subjects, has been strengthened and expanded. This is providing basic background as well as current material for supporting and guiding the activities of marketing specialists. In addition, it facilitates the evaluations of trends in production and trade patterns in both importing and competing exporting countries, and of developments generally in the field of foreign competition and demand for grain and grain products. This phase of the work should be broadened with increased emphasis because of its value in properly evaluating the competitive position of the U. S. in the world grain market. During the past year, 34 foreign agricultural circulars and many other special news reports on grain production and trade have been issued. These have received widespread attention in trade magazines and elsewhere. Several special reports have received particular attention, including a circular covering the price support policies and programs of the major wheat importing and exporting countries of the world, together with the level of wheat price supports in those countries. This has proved invaluable in studying the price factor as a part of the over-all program.

The work should be continued. (See proposals for Committee consideration)

2. Impacts of Grain Imports upon Domestic  
Programs and Policies

FAS

Studies are continuing to determine the effects of the importation of grains and grain products upon the Department programs and policies, particularly the price support program. Recent studies regarding oats and barley provided the basis for a decision not to reimpose quantitative limitations on the importation of these grains after the expiration of the quota period ending September 30, 1955.

This work should be continued. (See proposals for committee consideration)

3. Basic Data for Pacific Northwest Wheat

AES-AMS

During the year a bulletin was released which reported statistics on Pacific Northwest wheat acreage harvested, yield per acre and the production of wheat by varieties in Washington, Oregon, and Northern Idaho for the 1949 and 1954 crops. A more comprehensive bulletin is being prepared covering wheat statistics for the area which will include county breakdowns as well as State data and information on the supply and distribution of Pacific Northwest wheat. Quarterly estimates of supply and distribution of wheat in the area are being released currently and will be continued. The State of Washington and the Oregon Wheat Commission have cooperated by providing part of the funds for this work.

Publication:

Pacific Northwest Wheat, by Varieties, Acreage Harvested and Production, 1949 and 1954, USDA, June 1955.



## B. EXTENSION SERVICE

In the past year the State agricultural extension services in Illinois, Iowa, Kansas, Maryland, Minnesota, Missouri, Montana, Nebraska, North Dakota, and Oklahoma conducted educational projects on grain marketing under the Agricultural Marketing Act of 1946.

The Texas project has been temporarily suspended because of resignation of the project leader and lack of matching funds. In Oregon and Wyoming work on grain marketing is done in connection with the projects on seed crops marketing. Mississippi is doing some work on marketing oats, corn and soybeans as a part of a broader field crops marketing program. South Carolina has recently started a grain marketing program emphasizing storage, grading, and quality maintenance.

The following summaries of the programs by States indicate the types of work underway and some of the more important accomplishments:

Illinois.- The educational program in Illinois is aimed at improving the efficiency and services of country grain elevators. The areas of work emphasized in 1954 were:

1. Grade and price discounts for soybeans.
2. Grading and pricing hard and soft wheat according to market value.
3. Grain price trends and economic implications of price support programs.
4. Grain dealer management conferences.
5. Improvement of warehousing practices of country elevators and revision of Illinois Warehouse Act.
6. The 4-H Club grain marketing activity.
7. Increasing grain storage space.

The work on soybeans consisted of two phases: (1) to encourage the tightening of soybean grades on foreign materials and moisture and (2) to get understanding of grades and discounts by farmers, especially in newer producing areas. A series of wheat grading and marketing schools were held for grain dealers in 4 areas. Attendance at each meeting was limited to 25 dealers. The program included four features:

1. The hard and soft wheat situation.
2. Recommended wheat varieties.
3. How grades are determined.
4. Practices of grading wheat.

Licensed grain inspectors served as instructors on wheat grades and grading practices. The educational program on grain storage was approached on a selective basis in areas where the need existed. Emphasis was placed on expanding both farm and commercial storage and on improving storage practices. The grain marketing specialist sponsored the storage program on a State-wide basis in cooperation with ASC and other interested groups. He participated in a series of 8 area grain dealers conferences discussing storage and 6 county meetings. Additional

county meetings were held by farm advisors in cooperation with ASC. Two series of State-wide grain dealers management conferences were held dealing with handling wheat under marketing quotas, storage space and provisions and operating practices under the State Warehouse Act. A monthly letter entitled "Market Notes" was started as a means of keeping farm advisors and trade interests informed on current market conditions and problems.

Iowa.- The grain marketing program is conducted on a half-time basis in cooperation with research and teaching. Due to the limited personnel available for the project the leader is concentrating most of his effort on State-wide and area work. Use is being made of mass media (radio, television, press and college publications) in getting information on grain marketing to Iowa farmers and grain dealers. While the current program is considered to be quite successful, it is recognized that there is a need for helping county extension directors to devote more effort to educational work on improving local grain marketing methods and practices.

During 1954 the grain marketing specialist joined with extension agricultural engineers, agronomists, entomologists, ASC leaders and trade organizations in conducting a State-wide program to encourage construction of storage facilities and to promote better handling, drying and storage practices. Results of this effort is indicated by the fact that over 44 million bushels of 1953 corn under price support was resealed, which was 4 million bushels over the established goal. About 80 percent of the new elevator storage constructed in 1954 included provisions for mechanical ventilation. There was also noticeable improvement in the quality of corn delivered to bin sites and elevators for government storage.

Another important feature of the program is concerned with elevator organization and operation. With the support and assistance of grain trade organizations a resident teaching program has been developed and put into operation to provide in-service training for elevator employees interested in becoming managers of elevators and farm supply businesses. The trade is cooperating by giving scholarships and hiring students for three to six months placement training.

An annual 3-day elevator and feed managers conference was initiated in 1954 with about 100 attending. Plans are also being developed for an annual 2-week short course at Iowa State College for local elevator and feed dealers.

Other features of the educational program deal with seasonal price changes and outlook, grades and discounts, and joint activities with other specialists on storage, grain sanitation and quality preservation. The market information and outlook work has been quite successful in helping producers decide on storing soybeans rather than dumping them on the market at harvest time. Closer grading and discounts for lower quality by elevators and grain dealers is resulting in better grain marketing and increasing returns to producers.



Kansas.- Educational work on grain marketing in Kansas is a major phase of the State and county extension programs. A full-time marketing specialist is employed to work with county agents and trade interests. During 1954 the specialist participated in grain market situation and outlook meetings in 36 counties. State-wide coverage with current information on grain marketing is obtained through the daily press, farm and trade magazines, radio, television, and special news letters to county agents and grain dealers.

Grain grading schools continue to be a major part of the program. Eight district schools were held in 1954 providing training for 867 persons. These schools are held every year and are jointly sponsored by the Extension Service, Kansas Wheat Improvement Association, and the Kansas Grain and Feed Dealers Association. AMS grain grading personnel cooperate in conducting the grading schools.

Elevator sanitation demonstrations were given a trial run in 1954. Four of these were held under the same joint sponsorship as the grading schools. A total of 129 local elevator managers and operators attended these 4 demonstrations. The program featured recommended elevator sanitation practices for prevention of damage from insects, rodents, birds and other sources, agricultural laws affecting elevators, especially the use of chemicals, insurance protection and other factors. These demonstrations were successful and the program has been expanded in 1955.

Two-day wheat kernel identification schools were held at Hutchinson and Wichita with 166 students participating. These schools are designed to train elevator and mill personnel in kernel identification as a basis for determining variety and milling and baking characteristics. Kernel identification is being used more and more as a factor of quality determination in marketing.

A bookkeepers school for grain cooperatives is held annually at Kansas State College to train local elevator personnel in business record and management practices.

Ten district and county grain drying and conditioning schools were held in 1954. These schools were conducted in cooperation with agricultural engineers, agronomist and grain technologist. The objective was to help meet storage space needs and to improve storage operation and management practices. These schools were supplemented with extensive radio coverage, newspaper publicity, cooperation with State and county ASC offices and the individual efforts of county agents.

An extensive 4-H Club program is conducted on grain marketing. This program is integrated with other programs on production. Thirteen cooperative 4-H and FFA leader training schools were held on a district basis designed to aid in better understanding of the functions, operations and management problems of cooperative elevators. Five hundred 4-H - FFA members, 95 local leaders and 225 cooperative managers and directors participated in these schools. Wheat shows were held at Wellington, Wichita, Hutchinson, and Salina featuring 4-H work on grain production and marketing. 4-H Club members within a 50 mile radius of each show point were



invited to submit samples of wheat grown by them for grading and milling and baking tests. In addition to the competition of determining the winning samples each show featured a study tour of local grain marketing facilities and marketing operations, including futures market, milling and baking. There are about 3,000 4-H Club members participating in wheat projects. A definite part of these projects is devoted to training on grain marketing culminating in an awards program sponsored by the Chicago Board of Trade and involving county awards, State awards, and an educational trip to Chicago for State winners.

In 1954 wheat quality improvement was the number one feature of the educational program. The objective is to make Kansas wheat top quality for commercial bread making. The program starts with growers encouraging them to produce only the best varieties as determined by milling and baking tests, following recommended storage and handling practices and to develop a system of grading, pricing and quality differences that will provide incentive for quality improvement and maintenance.

Maryland.— The grain marketing educational program in Maryland in 1954 included 4 lines of activity; (1) wheat storage, (2) better marketing practices, (3) wheat allotments and quotas and (4) general information.

The storage problem was approached through an industry-wide conference at Baltimore in April to appraise the situation and make plans for action. Out of this conference came a committee to develop a program which all groups could get behind. The committee decided that expansion of farm storage was not the solution and proceeded to work on the basis of finding commercial space, both at country points and at terminals. The efforts to locate space were successful and the crop was handled with a minimum of difficulty.

High moisture content is a serious problem in handling and storing Maryland grain. Complaints were numerous that moisture determinations were quite variable and inaccurate. A check on the accuracy of moisture testers showed a wide variation. As a means of combatting this problem, a series of moisture tester demonstrations were conducted over the State to train country grain dealers and county leaders how to properly adjust and use the instruments. Tied in with these demonstrations attention was given to other grade factors. It is quite evident that this work is having a good effect on improving moisture testing and grading practices.

The grain marketing specialists participated in 4 county-wide meetings discussing with growers facts and conditions in connection with the wheat allotment and price support program.

A general grain marketing information program was carried out on a year-round basis. Grain marketing was featured about twice a month on the Department of Markets weekly radio broadcast emphasizing price support, demand and prices, storage problems, stocks, grading, insect control and farm drying. In addition each week the current price and demand

picture for local grain was carried on radio market news. Information on harvesting, storing, grading and marketing grain was given wide distribution through county agents and the press.

Two grain sampling and grading schools were held at Centerville and Salisbury in cooperation with the Grain and Feed Dealers Association. Grain inspection personnel from AMS Baltimore district office assisted as instructors for the schools. Ninety-two grain dealers and handlers registered at these schools.

Minnesota.— The grain marketing program is operated on a part-time basis in connection with other extension marketing work. The work on grain deals with marketing factors with malt barley, 4-H Club training, drying and storage, wheat allotments and price support, grain sanitation, terminal market study tours, and elevator operating efficiency.

Eight malting barley marketing meetings were held in cooperation with county agents. Problems dealt with in these meetings were barley grading, quality factors, trading on the Minneapolis exchange, varieties as related to marketing, and grain sanitation. Attendance at these meetings varied from 25 up to 240. An additional threshing and marketing meeting was held at Roseau with over 200 people attending. Eight combine dealers cooperated in this program demonstrating their machines and training farmers on proper adjustment and operating methods.

Assistance was given to four counties in connection with 4-H sanitation demonstrations.

Grain sanitation educational work was carried on in cooperation with entomologists and agricultural engineers. This subject was taken up in practically every program dealing with grain production and marketing throughout the year.

Grain storage continued to be an important part of the educational program, using educational materials previously developed. Other features of the program included work on wheat allotment referendum, grain market tours, annual elevator business meetings.

Consumer marketing information on bread and other cereal products is carried on in connection with the consumer program. The grain marketing specialist has cooperated with the consumer marketing specialist in preparing a special leaflet on bread and cereal products. The information in the leaflet forms the basis for a television show at Minneapolis. In addition it has been widely distributed over the State.

Missouri.— The grain marketing program in Missouri is on a half-time basis in connection with the program on cotton ginning and marketing. The work on grain and soybeans consists of a spring series of district grain grading schools for country grain dealers, soybean grading schools in August, county grain grading schools held by county agents, and monthly outlook and marketing information. Special emphasis has been



placed on the hard and soft wheat problem as it affects producers and the trade, differentials for quality, grain sanitation and storage. An extensive educational program has been conducted to expand farm storage and to take advantage of seasonal price rises for soybeans. There has been a big expansion in both farm and commercial storage. The marketing specialist also cooperates with the agricultural engineers in conducting combine - marketing schools for soybeans. These schools are helping to get improvement in soybean yields, quality and grades.

Montana.- County grain marketing meetings were held in 20 counties east of the Rocky Mountains in 1954. These meetings dealt with market conditions and outlook, grain contamination, moisture problems, drying and storage construction and operating practices and marketing high protein wheat. About 550 producers, grain dealers and others attended these meetings. In addition to these special meetings, county agents held other meetings where grain outlook and marketing was considered.

A special grain storage leaflet was issued on a basis for initiating an extensive program on expanding storage facilities.

Work with 4-H Clubs was a special feature of the grain marketing program. Leader training meetings were held at 4 locations at which time about 200 leaders were given training on how to conduct 4-H grain marketing tours and other features.

The first annual Montana 4-H grain award tour was held at Great Falls in cooperation with Atwood-Larson Company. Outstanding older 4-H boys from 16 counties were on the tour. This proved to be a most valuable educational tour and will be continued and expanded in 1955.

A marketing and outlook news letter is prepared for county agents. The material in these letters is used all over the State in local newspapers and farm magazines.

Nebraska.- The Nebraska grain marketing program covers a wide range of activities. There is a close working relationship with the Nebraska Grain Improvement Association. The main features of the program are quality improvement, work with 4-H Club and FFA, grain sanitation and market conditions and outlook information.

North Dakota. - The program in North Dakota provides for major emphasis on release of current information on market conditions and outlook. Special attention was given to Durum wheat marketing problems in 1954. An annual barley marketing clinic and show is held to deal with grading problems, quality factors and the relationships between the malting and feed barley markets. Grain storage and grain sanitation were major features of the 1954 and 1955 educational programs. Other features of the program are marketing tours for farm managers, district grain grading and marketing clinics for 4-H Club members, and work with elevators on grading and marketing problems.



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Oregon.- The Grain marketing program in Oregon is carried on jointly with the work on seed crops marketing. During 1954 expansion of grain storage was an important feature. Time was also spent on grading and pricing of malting barley. At present the barley situation is not clear and there is much misunderstanding among growers. More research and study of this problem is needed to guide educational work. Some attention is also given to the marketing aspects of grain sanitation. It is expected that this program will be greatly expanded in 1955. Market information and outlook are featured regularly in market information reports.

Oklahoma.- The Oklahoma grain marketing program includes the following features and activities:

1. Grain storage facilities - farm and commercial.
2. Grain sanitation - producers and elevators.
3. Market information and outlook.
4. Bookkeeping schools for co-op elevators.
5. 4-H wheat improvement program and wheat shows.
6. 4-H grain marketing program, training schools, team demonstrations and market tours.

In previous years grain grading schools have been held for producers, local grain dealers and elevator owners and operators.

Grain storage was expanded by 41.5 million bushels from 1953 to 1954 and has resulted in adding at least 10 million dollars in gross income to Oklahoma farmers.

Regional Hard Red Winter Wheat Program.- In addition to the State grain marketing programs there is a regional program operating in the hard red winter wheat States. The regional work is headquartered at Oklahoma A & M College with Mr. James Enix serving as project leader on a half-time basis. The other cooperating States are Texas, New Mexico, Colorado, Kansas and Nebraska.

The regional grain marketing specialist works in cooperation with the State grain marketing specialist on problems that are common throughout the hard winter wheat area. Contacts are maintained with the terminal markets serving the area and export trade interests. Wheat kernel identification work in the several States is coordinated through the regional project with a system of check samples sent out to variety pickers at elevators and mills for identification. This aids in maintaining uniformity and accuracy in kernel identification for variety as a factor in marketing. Grain market information and educational materials of region-wide interest are also prepared by the regional leader and made available to all of the States.

Grain Marketing Information for Consumers.- At the present time there are 39 States, Puerto Rico and Hawaii conducting marketing information for consumers. Emphasis in these programs is on working with urban consumers in metropolitan areas. There are now 67 city programs operating throughout the country, including 5 regional programs in New York, Boston, Wheeling and Cincinnati. The potential audience for consumer marketing information is about one-half of the total population. The material prepared for these programs goes out over radio, television and through the daily press, making it a mass media approach.

Bread and other cereal products are featured from time to time throughout the year in the consumer marketing information program. For example, "The Bread Basket" was the lead item in the April 1955 issue of Focus on The Food Markets released in New York. At other times the emphasis is on other products such as macaroni, breakfast cereals, prepared mixes, etc.

C. STATE EXPERIMENT STATIONS MARKETING PROJECTS USING  
MATCHED FUNDS

1. Patterns, Costs and Economic Efficiency of the  
Transportation of Iowa Cash Grain with Emphasis on  
Truck Improvement

IOWA

A summary of studies during the past year indicates several facts relevant to demand for transportation. (1) Comparison of receipts and shipments by all agencies indicates that a large portion of corn, oats and soybeans received were processed within the State so that movements were for relatively short distances. The demand for type of transportation is influenced by the location and demand for processed products. (2) Nearby all corn and oats were received by rail at terminals, flour mill and wet corn processing plants, indicating that through rail billings for grain and processed products required rail receipts. The same was true, to a lesser degree, for soybeans since more soybean products have a local demand. (3) Feed plants receive a large percent of grains by truck. Feed manufacturing is usually located in proximity of feed demand areas since transit balances of through rail rates do not apply to mixed feeds. (4) Plants that utilize water facilities for shipments of grain or grain products depend largely upon trucks for grain receipts.

2. Marketing Wheat, Corn and Soybeans in Maryland

MARYLAND

A survey of approximately 115 dealers and handlers of grain throughout the State has been completed. Operations of these handlers vary widely in volume of business, type of operation, kinds of grain handled, services performed and custom rates charged. Few dealers have an adequate knowledge of their costs of operation or economic conditions affecting their business. When data from these studies has been analyzed corrective measures will be developed which will benefit producers, handlers and consumers of grain and grain products.

3. Marketing Margins as Affected by Costs  
and Price Policy

CONNECTICUT

Attention was given to wheat storage policy, particularly the question as to the optimum volume of wheat to store in the United States in each year as related to production and carry-over stocks. The study is primarily statistical, involving the use of tabulating techniques to determine effects of following alternative storage rules.

4. Causes of Imperfections in Local Indiana Grain Markets : INDIANA

Preliminary work was started on reviewing available information and published reports from previous studies preparatory to developing a schedule to be taken from a sample of country elevators in 1955. Based upon previous studies of variations in prices paid for grains by local elevators it is believed that more adequate information on bids received by elevators in different parts of the State is needed.



5. Organization of the Market for Wheat

KANSAS

Work has been directed toward analysis of the impact of recent innovations in wheat production on the marketing system. Storage has become an increasingly important part of the wheat marketing process. New methods of harvesting present a problem of shrinkage and quality change during storage. Exploratory work indicates that moisture content and temperature are major factors in quality maintenance. The protein and protein fractions from flour derived from different varieties of wheat are being evaluated with respect to differences in quality.

6. Organization of the Market for Feed Grains  
and Feedstuffs

KANSAS

During the first year of this study data was collected on comparative pricing of feed grains and feedstuffs, the market organization of a major feed ingredient and the economics of marketing white as compared to yellow corn in Kansas. Market price relationships among corn, grain sorghum and oats were examined.

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#### D. SERVICE WORK BY STATE DEPARTMENTS OF AGRICULTURE

During the past year 12 State Departments of Agriculture carried on marketing service activities pertaining to grain. The work centered around technical assistance in improving and expanding existing drying, processing and storage facilities and building new ones, the collection and dissemination of basic data and local and nearby market information, and quality improvement and maintenance.

##### 1. Technical Assistance in Establishing and Operating Improved and New Processing and Storage Facilities

1955 Recommendation: "Expand programs to encourage and assist in the construction and modernization of grain handling, processing and storage facilities."

Additional funds permitted some expansion in this activity during 1955-56 as many States continue to recognize the need for new and improved facilities to market their grain products.

Because of inadequate drying, storage and processing facilities, much locally produced grain in the southeastern States suffers abnormal deterioration and, as a consequence, is sold at a substantial discount. The problem has become especially acute in recent years in these traditionally grain deficit States due to increased grain production brought on by diversification, improved varieties of grain, and better production and harvesting practices. Technical assistance in establishing and operating improved and new processing and storage facilities was provided in Virginia, North Carolina, Maryland, Kentucky, South Carolina and Indiana.

In North Carolina technical assistance was provided to grain handlers planning new grain handling and storage facilities with the result that 705,000 bushels of storage and drying capacity were completed the past year, and construction is underway on new facilities that will provide storage for an additional 150,000 bushels of grain. Similar assistance was provided under this project in Maryland and has resulted in the construction of storage capacity for 1,250,000 bushels of grain this past year and an additional storage capacity of 2,000,000 bushels is expected to be built during the next year.

Department specialists also provided assistance in North Carolina to 37 grain dryers on the proper temperature control to maintain the quality of grain, to 48 firms on the operation of the Tag Heppenstall moisture meters, and to 40 mill and elevator operators on grading, handling, and marketing of grain. It is estimated that the improved quality of grain and better bargaining position of the producer brought about by the availability of more and better marketing facilities have increased grower prices from \$0.05 to \$0.20 per bushel which represents an addition to income of about \$1,200,000 to North Carolina grain producers.

The technical assistance provided in remodeling of elevators and in modern bulk handling equipment in North Carolina has also resulted in an additional income to farmers of \$0.05 per bushel on corn and \$0.10 per bushel on soybeans.

In Virginia technical assistance was provided grain handlers and elevator operators in bringing about a greater use of up-to-date grain handling equipment and in the development of more adequate storage facilities. It is estimated that the technical assistance program during the past year resulted in additions to income of about \$75,000 or \$0.25 per bushel of grain to Shenandoah grain producers and handlers. These savings were largely attributed to the reduction of loading time at harvest, the use of improved types of unloading and grain drying equipment which is reported to have substantially reduced grain deterioration and other losses, and the economies resulting from the use of new and improved conveying equipment that now is making it possible for elevators to handle a greater volume of grain. Virginia Department of Agriculture marketing specialists during the past five years have provided technical assistance in grain handling practices which has been instrumental in bringing about a substantial reduction in grain marketing charges from the farm to terminal markets. For example, the price received by Virginia farmers for soybeans on the Richmond market in 1947 was \$0.74 per bushel less than the Chicago terminal market price. However, the margin of price spread for soybeans between the Richmond and Chicago markets was only \$0.14 per bushel in 1954. This reduction in marketing charges is estimated to have resulted in increased returns to Virginia soybean producers of \$0.60 per bushel, which amounts to an addition of about \$1,300,000 to farm income for the 1954 Virginia soybean crop.

The findings of a three-year Virginia farm storage survey indicated that it is practical to store grain on the farm providing that (1) the grain is of U. S. 2 grade or above, (2) farm storage facilities have waterproof roofs, sides, and adequate flooring, (3) the grain is properly fumigated and examined frequently, and (4) wheat does not contain over 14 percent moisture when placed in storage.

In Kentucky a survey was made to obtain information on the volume of grain production by county, volume of grain produced per farm, and on the condition and capacity of existing handling, drying, and storage facilities. These data were used as a basis for determining the equipment and storage facilities needed to effectively market Kentucky grain. A study was made in Henderson, Kentucky, to establish the grain storage facility requirements for this area. As a result of this work a one million bushel capacity elevator is planned and this new facility will make available much needed additional grain storage space in western Kentucky.

The technical assistance provided on the handling, care, storage and marketing of grain resulted in lower handling and marketing costs on



the millions of bushels of grain sold this year by South Carolina producers. The assistance provided also resulted in many thousands of dollars being added to the returns of producers and the grain industry in this State.

In Indiana 16 grain elevators and mills in 13 counties were shown how to improve the operations of their facilities, which resulted in increased operating efficiency. Technical assistance was provided in the construction of an Indiana grain elevator with an annual volume of business estimated at about one million dollars. The operation of this facility is expected to result in more efficient marketing of grain, which will be reflected in increased returns to farmers.

Publication:

Grain Marketing Facilities and Practices in South Carolina (publication at printers), Clemson Agricultural College, Clemson, S.C. (tentative date of publication November 1955).

2. ENCOURAGING THE USE OF FEDERAL GRADES AND  
MAINTAINING QUALITY IN MARKETING GRAIN

1955 Recommendation: "Expand programs to familiarize farmers and dealers with grain grades and encourage the use of grades for buying and selling."

Additional funds will permit some expansion in this field during 1955-56. It is anticipated that the grain grading work will continue to be an important part of the marketing service program in the leading grain producing States.

Marketing services designed to familiarize farmers and dealers with grain grades and encourage the use of grades as a basis for buying and selling were provided by the State Department of Agriculture in Virginia, North Carolina, South Carolina, Maryland, and Kansas. In Kansas this work has been concerned primarily with informing Kansas producers of the extent to which their wheat is discounted in price because of the milling quality from certain areas and the fact that there is little use of grade designation in pricing. Extension marketing specialists are encouraging growers to produce the varieties which have desirable milling and baking properties. In addition, Department specialists are encouraging the establishment of trading practices in which quality differences receive appropriate consideration in buying and selling. It is believed the adoption of such practices will provide growers with more incentive to produce desirable varieties, and dealers with a better basis for price negotiations with millers to develop quality standards which will make it possible to sell Kansas wheat to the mills of the world without discrimination with respect to meeting quality requirements of buyers. Cooperation in this work is being provided by the Kansas Wheat Improvement Association, Kansas State College, milling companies, and other interested groups.

In South Carolina to encourage grain sales on a Federal grade basis a chart on Federal grade standards for corn, oats, wheat, and soybeans was prepared and distributed to all mill and elevator operators, county agents and vocational agricultural teachers. Activities in connection with grain grading programs were instrumental in the establishment of the South Carolina grain inspection and grading service.

The North Carolina Department of Agriculture in cooperation with State Extension Service held grain schools throughout the State for demonstrating grain grading methods as part of the program to encourage the sale of grain on a quality basis. These grain schools were attended by producers, local agricultural workers, elevator operators, mill operators, shellers, and others interested in the marketing of grain. The Department held a five-day grain grading course at State College which was attended by representatives of 25 grain firms. In addition, representatives of four grain firms were provided technical training in grain grading procedures in order to qualify as licensed graders under the Federal-State warehouse system. The grain grading program is reported to have made many grain dealers and mill operators quality conscious with the result that the buying and selling of grain on a grade basis has increased in North Carolina.

The Federal inspection of soybeans in the Eastern Shore area of Maryland developed under this program was continued and 600 cars of soybeans were inspected. An exhibit on grain grading was held at the Maryland State Fair in cooperation with the Extension Service. This exhibit featured the procedures and equipment used in grain grading, moisture testing, and use of the representative sampling techniques in grain grading.

The Virginia Department of Agriculture also assisted grain producers and handlers in establishing marketing practices based on selling soybeans, and other grain crops on a grade basis. This program has resulted in the more orderly marketing of Virginia grain products and has also increased returns to grain producers and handlers.

In North Dakota a grain sanitation program has been initiated which principally emphasizes the elimination of contamination by rodents, birds, and insects. In connection with this project, 367 farm visits were made and contacts were made with 189 county agents, 38 grain elevator operators, 2 grain marketing agencies, and 5 government agencies. Also 2 interviews were held with newspaper editors and 2 radio and 2 television programs were presented in order to obtain cooperation on this project throughout the State. Several county-wide projects are scheduled for next year.

### 3. COLLECTION AND DISSEMINATION OF BASIC DATA AND LOCAL AND NEARBY MARKET INFORMATION

1955 Recommendation: "Expand work on the coordination and dissemination of basic market information." No additional funds were requested by State Departments of Agriculture for increased matching



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funds to collect and disseminate basic data and local and nearby market information as the activities under this phase of the program were not expected to undergo any major change with respect to the type of work or the level of activity.

Producers and processors need data on basic production and consumption trends in order to develop effective long-term marketing programs. Important types of information required are trends in acreage, production, changes in demand, the competitive price situation in markets, quantities in storage and the rate of disappearance, and cost data for handling, drying and storage. Basic data of this general type were collected, analyzed and reported to producers, dealers, and other interested groups in Maryland, Kansas, Indiana, Washington, Kentucky, Montana, South Dakota, Wisconsin, and Oklahoma.

In Maryland basic grain data were provided on quantities in storage, grade, and prices paid by buyers. These data were released in the weekly Maryland Grain and Hay Report and were also used as the basis for radio and television releases.

In Indiana basic information was provided on times to sell, market outlets, and on grain storage costs to assist farmers in the marketing of corn, soybeans, and wheat. These crops amounted to almost 200,000,000 bushels of grain in 1954-55. This basic information on grain crops was made available to all parts of the State in news releases and on six radio programs arranged to present the following: (1) the corn situation, (2) soybeans outlook, (3) grain storage costs, (4) feed outlook, (5) when to sell soybeans, and (6) storing and selling wheat. Articles on marketing soybeans and wheat were published in the Economic and Marketing Information for Farmers which is sent to more than 20,000 Indiana farmers. It is estimated that the more orderly marketing of soybeans last year resulted in a saving of \$0.15 per bushel, which was equivalent to nearly 7 million dollars of additional income to Indiana soybean producers.

Assistance was provided in Kansas and South Dakota to obtain basic data to determine the amount of on and off-farm storage for the 1955 crop. These data were used to evaluate types of storage facilities needed to efficiently handle the grain crops produced in these States. The Kansas Department of Agriculture also provided basic data on price movements, prices received, and estimates of cash income to wheat producers on a county basis. The Department also provided current information to wheat growers, grain dealers, millers on the protein content and the test weight of the wheat crop, by counties, as the crop moves to the first receiver. The 1955 Wheat Quality Survey sample included 5,277 carloads that had an average test weight of 61.1 pounds per bushel and an average protein content of 12.5 percent. Eight special news releases were issued during the marketing season in order to make the information available on a current basis. As a result of these reports producers were in a



better position to judge whether buyers are giving proper consideration to quality in pricing and also assisted millers and other grain buyers in locating grain of a specific quality.

Publications:

Production, Harvesting, and Marketing of Grains on Individual Farms in South Carolina. Circular 401, Clemson Agricultural College, February 1955.

Small Grains - Special Bulletin No. 54. Wisconsin Department of Agriculture, Madison, June 1955.

Montana Grains. Montana Department of Agriculture, Helena, October 1955.

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PROPOSALS FOR COMMITTEE CONSIDERATIONa. Varietal Improvement of Grain Crops

To develop superior varieties an expanded program of basic and applied research is needed: (1) to improve methods of producing hybrid sorghum and to develop hybrid varieties for the various sorghum growing areas, (2) to develop disease resistant winter hardy varieties of barley; to develop for the western states 2-rowed barley with superior malting quality; and to develop suitable malting barley for the North Central Region, and (3) on corn diseases, corn quality, and the mineral nutrition of corn.

Increases in funds during the last three years have strengthened certain lines of research but the above items are still inadequately supported. With the development of sorghum hybrids it now appears (1) that the yield increase in grain sorghum may be somewhat comparable to that attributed to hybrid corn, and (2) that suitable forage sorghum hybrids would permit the production of seed on short plants that can be harvested with a combine, yet the crop from such seed will produce plants as tall as and even more productive than, the standard forage varieties now in production. Increased pressure for the development of better 2-rowed malting barley for the irrigated lands in the west and better quality barley for the North Central Area will require expansion in these lines of research. The corn quality work is still inadequately supported.

b. Weed Control

Expand research on the control of weeds in wheat, corn, and sorghum, including studies on the safe use of herbicides.

There is need for a selective herbicide for control<sup>of</sup> weeds in small grains without injuring underseeded legumes. Limitation and restrictions on the use of 2,4-D, in certain areas, has resulted in severe invasion of weeds in wheat. New herbicides should be investigated for weed control in cereal crops.

c. Pesticide Residues

Expand work on pesticide residues on or in grains and in soils following treatment of these crops for pest control. Research is also needed to determine the nature and amount of chemical residues which may appear in milk, meat, or poultry, following consumption of crops treated with pesticides.

Increased public concern over hazards of pesticides and greater responsibility of the Department in meeting the rigid provisions of Public Law 518 (Miller Amendment), necessitates expansion of this work. Before new pesticide chemicals can be recommended for use

on raw agricultural commodities, adequate residue data must be obtained to show that tolerances established will not be exceeded. Attention will be given to the development of adequate methods of analysis for residues of the various materials under test. This expansion of research should include investigation of residues of systemic insecticides and their degradation products, and an evaluation of the effect of insecticides on the quality of foods.

d. Biological Control of Insects

Expand work on biological methods for controlling insects attacking grain.

This research should include investigations to determine the value of parasites, predators and insect pathogens in the control of insects attacking grain including corn earworm, European, Southwestern and other corn borers, corn leaf aphid, armyworms, and rice weevil.

Insect pathogens have shown promise in controlling some insects attacking grain. However, because of the complex cultural and environmental requirements of these pathogens, additional research is necessary before widespread use of them can be recommended.

e. Testing of Varieties for Resistance

Expand work on the search for and testing of varieties of grain for resistance to those insects causing major damage.

The progress already made in developing insect resistant grain varieties illustrates the value of this type of research. This work, which would be in cooperation with Federal and State plant breeders, should include basic studies to determine the cause or causes of plant resistance and the ability of the resistant varieties to influence the insect population. The spread of the European corn borer into the corn-growing area of the South and Southeast has increased the need for the development of corn hybrids resistant to this insect and adapted to this area. Likewise, the spread of the Southwestern corn borer into the corn-growing areas of Texas, Oklahoma, Kansas, and Arkansas, and the threat of its continuous eastward spread, justifies expanding cooperative studies to develop corn hybrids resistant to this insect.

f. Systemic Insecticides

Expand work on the use of systemic insecticides for the control of the major insects attacking grains.

Research with systemic insecticides should include basic information on their absorption, translocation and duration within the plant. Several systemic insecticides have been developed that will control sucking insects on plants. Their practical value for the control of pests such as leafhoppers, aphids, mites and thrips attacking grains and how and when to apply them should be determined.



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#### g. Insect Vectors of Diseases

Expand studies on insect vectors of diseases of grain.

This expansion should include studies to determine if the occurrence over a wide area of abnormal plants resembling yellow-dwarf in wheat and barley and red leaf in oats is due to insect transmission of a virus known to occur on the Pacific Coast.

The discovery that certain mites and insects are vectors of some of the mosaic diseases of grains suggests that these pests may be responsible for the transmission of other leaf diseases of grain. More rapid progress could be made in developing methods of controlling some of the virus diseases if it was known whether or not they were transmitted by insects or mites. The control of the insect vectors might prove to be the most feasible way of controlling the plant diseases involved. This work would be in cooperation with Federal and State pathologists.

#### h. Farm Drying and Storage of Grain

Expand research to minimize corn and small grain losses, promote grain sanitation and improve efficiency of crop production by: (1) Developing improved low-cost structures for drying and storing grain, with emphasis on protection of grain from insects, rodents and fire, ease of handling grain, and adaptability for use with other crops when not used for grain. (2) Finding how best to coordinate grain drying practices and building design with harvesting methods, crop rotations and variety selection.

Insect infestation is reduced by drying grain to safe moisture content before storage and maintaining the initial safe moisture level during storage by weather proof construction of buildings and aeration of grain to stop moisture migration. Adoption by farmers of grain, seed and forage crop drying as regular practices is bringing about changes in storage buildings, and harvesting methods, and no doubt will affect selection of crop varieties and crop rotation. For example, use of the picker-sheller or the corn combine followed by drying of the shelled corn permits earlier harvest, requires a bin instead of a crib for storing the shelled corn, and encourages early seeding of winter wheat or cover crops. In these developments most attention has been given to each element by itself. Now attention should be given both to continued improvement in the individual elements and to adapting cropping, harvesting and drying methods of each other so that the whole operation is most effective and economical.

#### i. Water Conservation Research

Expand research on the effects of moisture conservation on both yield and quality of grain.

This is true throughout the United States but particularly in the Great Plains States and the Pacific North-West where water is a primary factor limiting grain yields. This research will include the effect of residues and their management on water conservation, soil physical conditions, fertility balance, wind and water erosion control and water runoff on the yield and quality of grains.

j. Irrigation Practices in Relation to Yield and Quality of Grain

Expanded research to determine the proper time and amount of irrigation for efficient high production of grain crops throughout all irrigated areas of the U. S.

This is particularly true in the Mid-West and South-East where one or two irrigations may double the yield of many grain crops. It is also important throughout the irrigated west where water management is a primary factor in grain production. This research would include the determination of when to irrigate, how much water to apply and how best to apply it fertility requirements, and erosion control practices as they are related to yield and quality of grains.

k. Equipment and Methods for Pest Control

Initiate new work on the development and improvement of equipment and methods for air and ground application of herbicides and insecticides.

This work would consist of the development of aerial equipment for the application of liquid, dust and granular materials to grain crops. Of special interest at present is the need of both aerial and ground equipment for applying granular insecticides to corn for corn borer control. When suitable equipment is developed, it will be available for the application of pesticides or herbicides to other crops for both pest and weed control.

l. Economics of Farm and Land Management in the Great Plains

Expand research on economic problems of conservation and soil management, especially in areas of severe wind erosion, including investigation into the method for effecting shifts in land use where needed and maintenance of desirable land uses and farming practices.

An expanded economic research program in the Great Plains is urgently needed. Farmers there face unusual economic and production problems. The sources of these problems are a large surplus supply of wheat, a highly variable climate having at times prolonged periods of drought, and a difficult soil management and conservation situation. Additional economic studies should help farmers adjust sizes and types of farming and financial business methods and should provide a sound economic basis for farm policy and for emergency programs in the region. Well grounded economic studies require better understanding of drought hazard and of the relation between weather, crop yields, and soil management. Complementary studies in the economics of weather risks and on the operation of crop insurance, as well as other programs in the Plains, should be initiated.



a. Food Consumption Survey Analysis

Expand analysis of the food survey data collected in 1955 to provide as much information as possible about household consumption of major foods, such as grain products.

Examples are: The nutritional and economic significance of grain products in the diets of different groups in the population, changes in consumption patterns since earlier surveys (1942 and 1948) and the relationship of consumption of grain products in various forms to consumption of other foods.

b. Nutrients in Grain Products

Expand analyses for nutrients in foods to develop data on all nutrients for new foods and new forms of common foods which are not now included in tables of food composition.

Commercial processing and modern marketing methods are responsible for many new items in food supplies and diets about which nutritive value information is non-existent. Some are high-calorie, fat-processed ready-to-eat foods; others are formulated mixes for home cooking which are quite unlike household recipes in kinds and proportions of ingredients.

c. Basic Studies on the Composition, Properties and Chemical Reactions of Wheat Gluten

Expand studies on the composition, physical properties, and chemical reactions of wheat gluten both in its undenatured and denatured states to provide information basic to the improvement in properties and industrial value of gluten and wheat flour.

Wheat gluten comprises 80 to 85 percent of the total protein of wheat flour. Increased information on the physical and chemical properties of this protein in its undenatured state (as it exists in flour) and in the isolated state after separation from flour is essential to the recognition of properties on which the increased utilization of flour and gluten can be based. Although gluten is unique among the seed proteins in its ability to form a highly hydrated, cohesive, elastic mass, the relation of this property to the composition of gluten in terms of still undefined constituent proteins and their structure, or non-protein components such as the lipids or lipid-protein combinations remain to be established. Not only should such factors be investigated, but studies on the effects of physical and chemical treatments on gluten properties should be undertaken to effect modifications of properties which may lead to products having characteristics suited for practical uses not envisioned with presently available products. Basic to understanding of reactions of gluten protein, and to the utilization of its principal amino acids, will be a study of selected reactions of its constituent amino acids with organic reagents, including carbohydrates which may interact with proteins and amino acids in grain and grain products.



d. Chemical Modification of Wheat Flour

Initiate research on the chemical modification of wheat flour to alter and adapt its properties for the production of new industrially useful raw materials or to control its dough-handling and baking characteristics.

Since about 70 percent of domestically used wheat is made into flour, one productive approach to increased wheat utilization should be through a search for new and improved uses for this available and relatively inexpensive raw material. Industrial utility of wheat flour dispersions has been limited by unsuitable characteristics conferred by nature of the protein or the presence of fiber. Graded and controlled chemical modifications of flour with a variety of reagents known to react with one or more flour components or to effect particular structural changes should be investigated. Suitable alteration of the flour properties should result in the production of materials having improved solution properties and hence greater industrial utility. The mechanism of action of milder chemical treatments of flour, such as with oxidizing and reducing agents, should be investigated to provide a basis for developing treatments more effective in the control of dough-handling and baking characteristics.

e. Improved Utilization of Soft Wheats

Expand investigations on soft wheat flours to establish the relationships between their chemical composition, basic physical properties of doughs and batters prepared from such flours, and baking performance.

Flours from soft wheats have a unique area of usefulness distinctly separate from that for hard bread wheats. Within this area, the widely different nature of cookie doughs and cake batters, for example, suggest that a particular array of physical properties will be required for each different product, with corresponding differences in composition of flours. Information on these chemical and physical properties of soft wheats and flours lags behind that for bread flours, but is fundamental to adequate quality control in both the milling and baking industries, for variety evaluation in wheat breeding, and in general to the wider utilization of soft wheats. Work should be carried on in cooperation with Production units.

f. Methods for Measuring Physical Characteristics of Doughs and Batters

Initiate investigations on methods for determining the fundamental physical properties, such as viscosity, elasticity, and adhesiveness, of wheat flour doughs and batters.

Certain physical testing methods have become widely used in the milling and baking industry for the selection of bread flours. Although useful, these methods have been developed on an empirical basis; they do not measure specific physical characteristics nor are the results readily

interpretable in terms of these characteristics. Development of methods for measurement of various physical properties such as viscosity, elasticity, etc., would enable the usable range and optimum level of each property for different baked products to be established. This information would extend the application of physical testing to all types of flours and place the methods on a sound basis for use in quality improvement in the milling and baking industries and variety evaluation in wheat breeding.

g. Mixing Behavior of Flours

Initiate investigations to determine the features of composition responsible for differences in the mixing behavior of different flours when made into various types of doughs.

A major factor in the acceptability of wheat flour to the baking industry is the ability of the doughs to respond favorably to mechanical modification in the dough mixer and to tolerate a considerable degree of variation in mixing. These properties are considered of primary importance in determining product quality. Flours from different wheats differ markedly in these respects, but no basis for these differences has been established. The effects of separate classes of flour constituents and of chemical modification of specific reactive groups in the various constituents on the mixing behavior of flours should be determined. With relationships between composition and mixing properties established, more adequate quality control and wider utilization of wheats should be possible.

h. Processes and Equipment for Freezing Bakery Products

Expand research to develop optimum procedures and the most effective and economical types and assemblages of the necessary processing equipment for the freezing of bakery products, with initial emphasis on various existing types of bread, but eventually covering all major types of bakery goods including unbaked and partially baked products.

Practical experience with this method of extending the useful life of bakery products is still very limited, and the procedures and equipment used have not been broadly investigated from the standpoint of adaptation to the specialized requirements of the baking industry. Determination of the most effective and economical procedure and equipment for any type of product is a prerequisite to the conclusive showing of economic justification for freezing.

i. Frozen Preservation of Bakery Products

Initiate a research program to compare comprehensively, from the standpoint of attractiveness, convenience of preparation, palatability and nutritive qualities, major types of existing and experimental frozen bakery products which have been subjected to temperature conditions such as are encountered in commercial channels, so as to determine the relative merits and to develop improved methods of frozen preservation of unbaked, partially baked, and fully baked products.



When freezing is used for the preservation of bakery products, unbaked and partially baked items have certain advantages over fully baked products. Because the consumer completes preparation of these items by baking, the problems met in defrosting quantities of bakery products are avoided. Also the products are oven-fresh and the problem of staling is not encountered. These advantages may be lost, however, if certain technological problems, e.g., loss of leavening and instability of emulsions to freezing conditions, are not dealt with adequately. The envisioned research will doubtless point the way to development of new, more desirable bakery products.

j. Basic Studies on Cereal Starch Properties

Expand fundamental studies on the physical-chemical properties of cereal starch granules, dispersions, and films, and on the nature of both the chemical and physical interactions of starch with cellulosic materials, to provide information basic to increased utilization of cereal grains.

Industrial uses of cereal starches as sizes, fillers, adhesives, and the like depend largely on the ability of granular starches to swell and disperse in water, giving viscous pastes which form adherent films on drying. The scientific principles governing this adherence of starch to materials such as paper and textile fibers are little understood. Likewise, there is a need to develop an understanding of many fundamental aspects of granule structure which determine swelling properties, as well as factors which control the rheological properties of starch pastes. Such information is basic to the increased utilization of starch from cereal grains in present applications, in improving its competitive position with synthetic sizing agents, and in promoting incorporation of greater amounts of starch in consumer goods such as paper and textiles which are produced in large volume.

k. Composition of Cereal Forages

Initiate research on the composition of cereal forages (i.e., cereal grasses, sorghum, and corn forages) with particular attention to the physiologically active constituents and the enzyme systems responsible for loss of dry substance and essential nutrients.

General feeding experience has indicated beneficial and, in some cases, deleterious nutritive factors to be present in cereal forages. There are definite indications that the change to a more predominant type of grassland agriculture in this country is being hastened through acreage regulation of certain cereal grains and cotton. The increasing importance of forage feeding in animal agriculture makes it all the more desirable that needed information be at hand to realize fully the benefits of this type of farming. Full knowledge of the composition of the cereal forages and the changes they undergo in processing and handling for maximum retention



of valuable nutrients is essential to the processor, as well as useful to the grower, the animal nutritionist, and the plant breeder in providing the highest quality products meeting the nutritional demands of poultry and livestock. Prevention of the deterioration and loss of nutritive elements in freshly cut forages is of first importance in conserving the full value of these important crops. Many reactions that lead to losses in dry matter, vitamins, nutritive value, palatability, etc., are due to enzyme action. Knowledge of the enzymes present, their mode of action, and the conditions favorable and unfavorable to their activity is needed in order to prevent the action of enzymes causing unwanted reactions.

1. Characterization and Evaluation of Cereal Residues (Cobs, Stalks and Straw)

Expand fundamental investigations of chemical, physical, and biological properties of corncobs, stalks, and straws and the evaluations of these materials for specific new outlets, with special attention to those developments and uses which may form a part of the farm enterprise, such as the conversion of agricultural residues to soil conditioners and aids in soil building and erosion control.

Uses for agricultural residues stem intrinsically from their specific chemical composition and physical properties. Thus, the maximum yield of pulp from straws (and therefore the economic position of the straw-board industry) is determined by the amounts and kinds of individual carbohydrate and fiber constituents in wheat straw; the nutritive value of corncob roughage in cattle rations is determined by the kinds and amounts of chemical constituents comprising the cob and by the digestibility coefficients of each constituent; the desirability of corncobs as an industrial raw material for furfural production are directly determined by their pentosan content; the effectiveness of corncob products for cleaning and polishing in the metals-fabricating and finishing industries is related to their hardness, resiliency, and absorptive character.

On the basis of early findings a promising high potential outlet for agricultural residues exists in upgrading these materials as soil-conditioning and building agents through simple chemical and microbiological conversion processes. Particular attention should be given those treatments which may be carried out as a part of the farm enterprise with readily available farm equipment.

Complete information on residues will point the way to the most sound, efficient, and profitable returns from these materials, whether for industrial processing, for agricultural chemicals, for conversion to improved soil amendments, or for animal feeding.

m. Enrichment of Cereal Grains with New Growth Factors

Initiate a search for microorganisms to enhance the value of grain by fermentation to impart nutritional growth factor substances.

Cereal grains are deficient in certain vitamins and growth factors essential for their most efficient utilization by animals. One such deficiency was overcome by fermentation with selected microorganisms, namely, with vitamin B<sub>12</sub>-producing microorganisms, to produce supplements which resulted in improved growth rates of animals and greater consumption of grain products as feed, and in fermentation processes. The fermentation of grain is a means for producing other essential factors which are present in certain natural products but deficient in grains. To initiate this work microorganisms in the Culture Collection will be surveyed for producers of new vitamin-like factors, such as the fish solubles factor, distillers solubles factors, whey factor, and alfalfa factor. The discovery of a rich source of these factors will add to the nutritional value of grain and, also, utilize additional grain for the production of the factors.

n. Determination of Complete Chemical Composition of Wheat and Corn

Initiate a systematic determination and characterization of the chemical constituents of wheat and corn to exploit fully the natural superiority of these grains for preferred quality uses.

Although the major chemical constituents of our two most abundant grains have been known for some time past, the fact still remains that about five percent of their dry substance remains unidentified chemically even by class of compound. Within the classes of constituents such as starch, protein, oil, sugar, pentosan, cellulose, lignin, and ash, a great number of fractions and sub-fractions remain unidentified. Knowledge of the complete make-up of grain substance is of primary importance in the development of widest uses and markets for grain and its products. This is particularly true when one seeks to find specific uses for which a natural superiority of the grain fits it. A general program on the characterization of all constituents will logically include their identification by class as well as the more important sub-classes or fractions. Ultimately, the program will require extension to take into account the differences between varieties. Because of the great importance of corn and wheat for feedstuffs, it would be wise to give initial attention to studies on growth-promoting and growth-inhibiting factors, antimetabolites, toxic substances, essential amino acids, vitamins, pigments, etc. Institution of studies in this work area is particularly timely, and progress should be rapid because of the availability of the many advanced analytical methods recently developed, such as vapor-liquid chromatography, countercurrent distribution, complex formation, zonal electrophoresis, etc.

o. Improved Methods for the Dry-Milling of Corn

Initiate research on improving the unit operations involved in dehulling and degerminating corn in order that these steps in the dry-milling process may be conducted more efficiently, thereby increasing the yield and quality of the products obtained.



The dry milling of corn is an old art and few fundamental changes in methods of operation have been introduced even in recent years. Millers agree that an efficient method for dehulling corn before it is subjected to further processing would give products of greatly improved quality. Such a process following by effective degermination prior to the grinding of the endosperm would improve the quality of the products still further and permit the recovery of more oil. Under present practices the cleaned corn is first ground in a machine that is mistakenly called a degerminator. While some particles of free germ are produced much of it remains attached to the hulls and small grits. Subsequent grinding, sieving and aspirating operations are unable to effect a clean separation of fiber, germ and endosperm so that each fraction is contaminated with varying amounts of the others. Although corn contains 2.1 to 2.3 pounds of oil per bushel, and most of it is present in the germ, current practices result in the removal and recovery of only 0.5 to 0.7 pound of oil per bushel of corn that is dry milled. Most of the unrecovered oil appears finally in aspirated fractions that are sold as feed but some of it remains in the grits, meal, and flour resulting in the development of rancidity in these food and feed products. The increased operating efficiencies, better yields, and products of higher quality resulting from improvements in dry-milling methods would enhance the value of corn and expand its use as a food grain.

p. Composition and Kernel Structure of Grain Sorghum

Initiate systematic studies on the composition and kernel structure of grain sorghum, with special attention to components of potential commercial interest or of possible nutritional importance, and to structural factors basic to the development of improved processing methods.

Grain sorghum production in 1955 is estimated to be 14 percent above the 1950 record high, thus increasing the current overabundance of cereal grains. The recent introduction of hybrid seed will further stimulate sorghum production. Full knowledge of composition and kernel structure of grain sorghum is essential as a foundation for and guide to the most effective utilization of this grain for feed, food and industrial purposes, to the development of more valuable varieties through breeding, to the determination of compositional changes resulting from handling and processing, and to the development of improved methods for milling and processing the grain. For example, attention should be given to the nature and structure of the pericarp pigments in sorghum grain which may be of significance of quality of products obtained by processing; to minor components of possible biological activity such as the yellow endosperm pigments of newly introduced varieties; to compositional factors which may be responsible for reported deficiencies in feed value of sorghum gluten meal; to microscopic studies of kernel structure and structural components which may affect the efficiency of industrial processing of the grains; and to improved methods for separating grain components from one another.



a. Efficiency in the Use of Marketing Resources

An appraisal should be made of recent changes and adjustments in the use of marketing resources, market structure and marketing practices for wheat and other grains and of the efficiency with which marketing resources are being utilized. The study should include the effect of Federal programs relating to production and marketing of grain. Programs initiated in 1928 with the Federal Farm Board and continuing through the present time for the purpose of supporting the level of farm income have caused substantial changes in the marketing system.

b. Shift to Weight as Basis for Trading in Grain

Initiate research to evaluate the merits of the problems involved in shifting trade in grain from bushels to 100-pound units. The analysis should include a study of the legal obstacles, institutional changes and statistical data adjustments required in event such a change were initiated.

c. Storage Requirements for Protection Against Loss and Deterioration in Quality

Initiate research on storage requirements of grain to secure further information on the interrelation of time, temperature, moisture and humidity in storage as it affects microbiological and physiological deterioration and loss of germination. Although much work has been done on these problems, changing storage facilities and methods make desirable re-evaluation of information now on hand and securing additional information on specific problems. Such work would include studies on water imbibition, grain coat permeability, aerobic and anaerobic respiration, enzymatic and non-enzymatic reactions and the effect of temperature, moisture, light, and other chemical and physical treatments on the physiological processes. Grain from different growing conditions, climatic conditions at harvest, and methods of drying should be studied. Charts prepared from such data would be valuable for indicating the storage potential for different lots of grain and for developing methods for increasing the storage life of grain.

d. Microbiological Investigations on Grain in Storage

Expand research on the cause and control of diseases in grain after harvest including studies on the identity and relative prevalence of microorganisms on grain in storage, the damage caused by them and the conditions affecting their development.

Mycological and bacteriological studies would be made to identify the bacteria and fungi present in different kinds of grain under different storage conditions. The effect of growing conditions and climate at harvest, drying methods, and temperature and moisture during storage on development of fungi and bacteria would be determined. The effect of fungi and bacteria on composition and on germination would be studied. Especial emphasis would be placed on developing disease control methods.

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e. Evaluation of Product Quality

Expand basic research on quality evaluation to determine the feasibility of using physical or biophysical methods for measuring quality in grains.

This research would place special emphasis on microwave spectroscopy, nuclear magnetic resonance absorption, bioelectric potentials, and spectral absorption characteristics to determine if such techniques are suitable for indicating various quality factors of grain moving in marketing channels. These techniques could be of value in developing instruments for measuring such factors as moisture content, viability, insect infestation, and presence of foreign matter. Present methods of measuring these same quality factors are in many instances unsatisfactory. A new approach to the problems could provide the basis for an improved grading system for grains.

f. Control of Insects that Infest Stored Grains

Expand research on the control of insects that infest stored grains in relation to (1) improved methods of preventing infestation in stored grains, (2) insect control procedures for use in mills, bakeries and processing plants handling cereal products that will not result in contamination of the products by undesirable insecticidal residues and (3) insect resistant packaging to protect cereal products in marketing channels.

The grain and milling industry needs improved procedures for the fumigation of grain in flat storages; further exploration of the recirculation method of applying fumigants using existing aeration systems; a simple quick test for hidden infestation in wheat; better knowledge of the influence of temperature and moisture content of grain on the effective dosage rate of fumigants; further exploration of protective sprays and dusts for grains and determination of safe residue levels and permissible tolerance under the Miller Bill; evaluation of new procedures for spot or complete fumigation of flour mills and bakeries; development of standard procedures for insect control in mills, bakeries and warehouses in a manner which will prevent accidental contamination of the products by insecticidal residues; perfecting new methods and standards of cleaning freight cars or other means of transport to prevent insect invasion of products while in transit; and insect resistant packaging which will meet approval of the Food and Drug Administration.

g. Farm to Elevator Grain Movements

A study should be initiated to analyze grain, farm to market movements as they influence local elevator size and location.

This is an important problem area for those buying or building an elevator that will receive grain directly from farmers. Study of the problem should provide information on how far farmers will haul grain



beyond their nearest elevator for an additional cent per bushel. It should provide helpful information on the specific influences of other factors such as the elevator harvest season waiting time to unload, availability of storage, grading and pricing practices, and employee characteristics, that influence farmers to by-pass a near-by elevator in favor of another at a larger hauling distance.

h. Elevator Management Organization and Personnel Qualifications

Studies should be initiated to determine the type of management organization and employee qualifications that are best adapted to present and further scale of operations of the large country elevators.

The long time trend from one or two-man elevator operations toward several men and even several operating departments or branches seems likely to continue. Many very successful elevator managers of one or two-man operations are ineffective when they advance to a position requiring more delegation of authority and responsibility. Research on this problem is needed which will provide guides to such managers in making necessary adjustments on jobs with larger elevator operations and responsibilities. Also, information is needed that will be helpful in selecting employees for jobs and for training in jobs, particularly for the larger local elevator operations.

i. Consumer Preference Tests for White Pan Breads

Expand preference tests of bakers' white pan bread to one or more cities in regions of the country separate from Rockford, Illinois.

The purpose of such additional tests will be to determine if consumer preferences for the test formulations used in Rockford differ by location. The new tests replicate the Rockford study. Selected formulations from the two Rockford experiments will be submitted for preference testing. Data from such tests will serve to broaden the base of the Rockford data and to indicate regional differences in preference for bakers' white pan bread if such exist.

j. Consumer Use of and Opinions about Bread and Rolls

Initiate a study of household consumers use of bread and rolls with particular emphasis on who within the family eats bread, who does not eat it, reasons for non-consumption, personal characteristics of the low users or the nonusers, complaints about bread usually available to them, desirable characteristics of commercially baked bread, usual frequency of serving, meals at which white pan bread is served.

Additional information would be collected on consumers awareness of enrichment and other nutritive values. Consumers would be asked whether they had changed their level of consumption of bread and



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rolls in an attempt to discover whether it was related to quality of bread, attitudes toward dieting, or change in family age or composition. Some data would be collected on trends in baking of bread and rolls in the home, whether the homemakers were using brown and serve, ready mixes, or baking from basic ingredients, and whether they considered that these products were taking the place of regular commercial breads or whether it was used in addition to regular bread.

This information would give suggestions to the direction in which product improvement should go and give a framework for industry's promotion programs. It would also give some suggestion as to whether it is reasonable to expect that consumption of bread and rolls can be increased over a long range period.

a. Seed Storage Facility

A National Seed Storage Facility should be developed for the purpose of preserving collections of foreign and domestic plant species, varieties, and strains that are becoming difficult to obtain, and also for preserving valuable existing stocks in the hands of breeders.

b. Field Crops Physiology Laboratory

A central laboratory should be established for research on physiological problems of field crops involving studies on the effects of drought, winter killing, high temperature and other environmental factors on the growth and development of grain and other field crop varieties and in the development and distribution of diseases that attack them.

Lack of cold and drought resistance in our present varieties have resulted in the abandonment of approximately 10 percent of the total acres of wheat, oats and barley grown in the past 10 years. The same factors are responsible for comparable losses in forage crops and complicate the problem of establishment of range and pasture lands. Lack of cold resistance prevents the favorable practice of early seeding of sugar beets. Weed control research should be coordinated with other physiological studies since herbicides cause chemical changes that might be reflected in tolerance to drought and cold. Research now being done is entirely inadequate to solve these important problems and at the present there is no facility available in which to conduct a coordinated research program, results from which will minimize the hazards and stabilize production of these important crops.

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SERVICE WORK OF USDA(a) Foreign Market Development for Grain and Grain Products

Expand the present program directed at maintaining and extending foreign outlets for U. S. grain and grain products.

The increase in U. S. exports of grains in 1954-55 may be partially attributed to the effectiveness of the work done in this field. The program should continue to include the utilization of grain marketing specialists and agricultural economists to conduct field surveys and to study and report upon actual and potential sources of competition with U. S. grain in Western Europe, the Far East, Latin America, and elsewhere. Specifically, emphasis should continue to be placed upon:

1. Maintaining and expanding existing markets. The program aimed at increasing markets for U. S. grain and grain products should be expanded. Additional market development projects under P.L. 480 are needed to show bakers and housewives in Asia, Latin America, and perhaps elsewhere, how to use U. S. grain and grain products. Projects for increasing consumption (and imports of U. S. grain) in importing countries should be expanded. Emphasis also should be placed upon acquainting grain producers and exporters with the facts regarding the competitive position of the U. S. in foreign markets. This includes information on the requirements of the people over-seas with respect to particular types, grades, and qualities of wheat, barley and other grains needed and the actual and potential availabilities of such grains from competing exporting areas.
2. Study of quality of grain. Additional information is needed regarding the quality of grain exported from the U. S., compared with that from other supplying countries. Some progress already has been made in this field and additional wheat samples are being collected in European markets for subsequent laboratory tests to determine the milling, baking, and other characteristics. Consideration should be given to extending this study to include other grains and other markets so as to provide a reasonable quality comparison between all grains exported from the U. S. with those of our competitors.
3. Competition studies. Work should be continued and expanded in the field of determining foreign governmental policies and programs, and other factors bearing upon the competitive position of the U. S. in foreign markets.
4. The wider and more effective use of basic data available from Foreign Service and other reports. The program of collecting, analyzing, and disseminating foreign information on production, trade, consumption, utilization, and related information, should



be further strengthened and expanded. This provides background material for supporting the activities of FAS and other agencies in a wide variety of activities including the administration of Public Law 480, the Mutual Security Act, and related work. The collection and interpretation of this type of data facilitates the evaluation of trends in production and trade patterns and is essential to determining the actual and potential competitive position in the world's grain market.

(b) Quarterly Stock Reporting for Durum Wheat

Stocks of durum wheat should be reported as a separate item in the regular quarterly grain stocks reports. Present practice is to combine estimates of durum wheat stocks with those for other wheats in the "all wheat" category. The problem of durum wheat stocks is particularly acute this year because of the relative shortage of durum supplies. Specific questions could be added to existing questionnaires used to obtain stock information.

EDUCATIONAL WORK

a. Grain Grading and Marketing

Continue and expand grain grading and marketing schools for producers, country grain dealers and elevators to improve and extend the use of grades in handling and marketing grain and oilseed crops.

b. Grain Sanitation

Continue and expand educational work with producers, local elevators, transportation companies, terminal elevators, mills and processing plants on the prevention and control of insects, rodents, and other sources of contamination.

c. Storage and Marketing Facilities

Expand and further develop educational work with producers and the trade on using better storage methods and practices and the provision of adequate facilities for drying, storing, handling and processing grain commodities.

d. Kernel Identification

Continue educational training services with grain dealers, mills and local and terminal elevators in the use of wheat kernel identification for variety and its use as a factor in quality determination and marketing.

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e. Elevator Management and Operation

Continue and expand educational work with local elevators on problems and improvements in the business organization and efficient operation. Such training programs should include provision for dealing with such problems as capital requirements, equipment, records, marketing practices, labor management, risk bearing, supplementary enterprises, etc.

f. Consumer Education

Market information for consumers on grain and cereal products should be continued and expanded in marketing educational programs for consumers.

STATE DEPARTMENTS OF AGRICULTURE

Expand market service programs carried out by the State Departments of Agriculture with emphasis on the following programs:

- a. To improve existing facilities and design and locate new storage and processing facilities such as grain elevators and mills, and advise operators handling grain with respect to kinds of equipment and methods best suited to their operations.
- b. To provide marketing services designed to familiarize farmers and dealers with grain grades and encourage the use of grades in the buying and selling of grain, as well as activities to maintain quality in marketing grain.
- c. To prevent deterioration and contamination of grain storage.







